INTERNATIONAL CIVIL AVIATION ORGANIZATION

South American Regional Office

Fourth Workshop/Meeting of the SAM Implementation Group
Regional Project RLA/06/901

(SAM/IG/4)

FINAL REPORT

(Lima, Perú, 19 – 23 October 2009)

SAM/IG/4

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HISTORY OF THE MEETING

I PLACE AND DURATION OF THE MEETING

The Fourth Workshop/Meeting of the SAM Implementation Group (SAM/IG/4) was held at the premises of the ICAO South American Regional Office in Lima, Peru, from 19 to 23 October 2009, under the auspices of Regional Project RLA/06/901.

II OPENING CEREMONY AND OTHER MATTERS

Mr. Carlos Stehli, Deputy Regional Director of the ICAO South American Office, greeted the participants and expressed his gratitude to DGCA Peru, for the continuous support provided to activities developed at regional scale by the South American Office, as well as to the civil aviation authorities and national and private organizations from the ICAO South American Region, as well as the FAA for the continuous support to the activities of the SAM Implementation Group. Finally, he pointed out the importance of issues to be dealt with in the agenda of the Fourth Workshop/Meeting, which will allow the review of the matters dealt with during SAM/IG meetings. He emphasized that the teamwork shown by the Implementation Group is essential to execute the projects adopted by the Region.

Mr. Eliseo Salcedo Mitrani, Director of Aviation Safety, on behalf of the General Director of Civil Aviation, welcomed the participants, highlighting the importance of the issues to be examined at regional level, opening the meeting.

III SCHEDULE, ORGANIZATION, WORKING METHODS, OFFICERS AND SECRETARIAT

The Meeting agreed to hold its sessions from 09:00 to 15:00 hours, with appropriate breaks. The work was done with the Meeting as a Single Committee, Working Groups and Ad-hoc Groups.

Mr. Miguel Angel Castillo Ochoa, delegate from Bolivia, served as Chairman of the Meeting and Mr. Guillermo R. Cocchi, delegate from Argentina, acted as Vice President.

Mr. Jorge Fernández, RO/ATM/SAR of ICAO Regional Office, Lima, acted as Secretary, assisted by Messrs. Onofrio Smarrelli, RO/CNS from the Lima Office, and the Project RLA/99/901 Experts. Likewise, the Secretariat had the support of the Implementation Groups Rapporteurs, Messrs. Julio Pereira, PBN Rapporteur, Wagner Vitale, ATFM Rapporteur, Omar Gouarnalusse, CNS Rapporteur, Murilo Loureiro, Automatition Rapporteur, and Mr. Roberto Arca Jaurena, Implementation Groups Coordinator, to analyze de different agenda items.

IV WORKING LANGUAGES

The working language of the Meeting was Spanish, with simultaneous interpretation in English, and its relevant documentation was presented in Spanish and English.

V AGENDA

The following agenda was adopted:

Agenda Item 1: Monitoring to Conclusions and Decisions adopted by SAM/IG Meetings

Agenda Item 1: Monitoring to Conclusions and Decisions adopted by SAM/IG Meetings

Agenda Item 2: Optimization of the ATS routes structure

Agenda Item 3: Implementation of performance-based navigation (PBN) in the SAM Region

Agenda Item 4: Standards and procedures for performance-based navigation operations approval

Agenda Item 5: Implementation of air traffic flow management (ATFM) in the SAM Region

Agenda Item 6: Assessment of operational requirements in order to determine the implementation of communications and surveillance (CNS) capabilities improvement for en-route and terminal area operations

Agenda Item 7: Operational implementation of new ATM automated systems and integration of the existing systems

Agenda Item 8: Other business

VI ATTENDANCE

The meeting was attended by 57 participants from 11 States of the SAM Region, Argentina, Bolivia, Brazil, Chile, Colombia, Guyana, Paraguay, Peru, Suriname, Uruguay and Venezuela, 1 State of NAM Region: United States, and 6 International Organizations; ARINC, Avianca, EMBRAER, IATA, LAN and Jeppesen. The list of participants is shown in pages iii-1 to iii-11.

VII LIST OF CONCLUSIONS

Agenda Item 1: Monitoring to Conclusions and Decisions adopted by SAM/IG Meetings

Review of the status of compliance of conclusions formulated by SAM/IG Meetings and pending activities

1.1 During the analysis of this agenda item, the Meeting recalled that the activity related with ATS routes network optimisation has been faced in two different manners. Through the implementation of routes and/or realignment of RNAV routes, and the elimination of conventional routes, and the implementation of the ATS Routes Network Optimization Programme.

1.2 The Meeting has also considered RNAV 5 implementation for en-route operations, as well as STAR and SIDs in terminal areas and instrument approach procedures for the main airports of the Region, applying RNAV/RNP, RNAV AR APCH and/or APV Baro/VNAV procedures, is part of the ATS routes network and regional airspace optimisation.

1.3 The Meeting took note that, two procedures design courses RNAV/RNP and RNP AR APCH were dictated through a Special Implementation Project (SIP) financed by ICAO and Regional Project RLA/06/901, in which experts in procedures design participated, from 9 States of the Region in each course.

1.4 As a follow-up to conclusions and activities, the Meeting noted that, as agreed during the SAM/IG/3 Meeting, work continued with the ATFM Manual, and the Guide for the use of a common methodology for the estimate of airport capacity and ATC sectors. Such document presents information on the different methodologies and proposes the use of a specific methodology.

1.5 Within the environment of the activities related with CNS and automation improvements, as support to the implementation works of different ATM elements, guidelines were developed for the implementation of CNS Systems improvement, as well as in the implementation of automated systems, as well as the interconnection of the same.

1.6 Almost all the States of SAM Region prepared action plans for the improvement of CNS systems to meet operational requirements in the short and medium term for en-route operations and terminal area.

1.7 To support SAM Region States in the interconnection of AMHS systems, a guidance material for AMHS interconnection systems was prepared, and a guidance document on procedures to SAM Region States in the implementation of national networks using IP protocol, was also prepared. Likewise, a Memorandum of Understanding (MoU) model for the implementation of the AMHS systems interconnection was also developed. Some States in the Region have already drawn up and signed the corresponding MoUs.

1.8 A preliminary data bank was also prepared with coverage data on some of the VOR/DME installed in the SAM Region and an initial revision of VOR/DME and DME/DME coverage to support RNAV 5 operations was carried out.

1.9 In view of the above, and the information provided by States on the works carried out regarding conclusions and actions adopted, the status of compliance was updated, as shown in **Appendices A, B, C and D** to this part of the report.

APPENDIX A

STATUS OF APPLICATION OF CONCLUSIONS AND/OR TASKS ORIGINATED IN SAM/IG MEETINGS

No.	Task to be developed	Specific tasks	Deliverables	Finalization date	Responsible	Supporting members to the task	Status of implementation
1. ATS Routes Implementation							
1-1 Prev. 1-4	That States examine: a) Impact of RNAV routes implementation in t he airspace b) Aircraft fleet c) Air traffic services, and d) Establish pertinent coordination so as to enable integrated, harmonious and timely implementation of more direct RNAV routes.	Analyse airspace Evaluate national and international fleet Evaluate ATS Coordinate with authorities involved Coordinate with adjacent States, if necessary	Adequate information will be available to execute PBN action plan. A new ATS routes network will be available, based on RNAV with necessary PBN values, so as to respond to current requirements of airspace users	SAM/IG/7	States	RO/ATM RO/AIM	Valid
1-2 Prev 2-1	Route RNAV VOR CRR/VOR FNO (UM 661)	Coordinate the implementation. Issue AIC. Train personnel. Amend CAR/SAM ANP	Route implemented	TBD Information from Brazil is pending	States Secretariat	RO/ATM RO/AIM	Completed

No.	Task to be developed	Specific tasks	Deliverables	Finalization date	Responsible	Supporting members to the task	Status of implementation
1-3 Prev 2-1	UM 662 Guayaquil – Madrid	Coordinate the implementation. Issue AIC. Train personnel. Amend CAR/SAM ANP	Route implemented	Agreement with FAV Venezuela is pending	States Secretariat	RO/ATM RO/AIM	Completed
1-4 Prev 2-1	UM 527 Lima – Madrid	Coordinate the implementation. Issue AIC. Train personnel. Amend CAR/SAM ANP	Route implemented	Implementation agreement on 24 September 2009	States Secretariat	RO/ATM RO/AIM	Completed 24/09/09
1-5 Prev 2-1	Santiago-Miami	Coordinate the implementation. Issue AIC. Train personnel. Amend CAR/SAM ANP	Route implemented	Finalise coordination with States involved and IATA	States IATA Secretariat	RO/ATM RO/AIM	Completed Appendix A to Agenda Item 2, was modified. An analysis will continue within the SAM ATS routes network optimization programme.

No.	Task to be developed	Specific tasks	Deliverables	Finalization date	Responsible	Supporting members to the task	Status of implementation
2. Optimisation of ATS routes in the SAM Region							
2-1	**Conclusion SAM/IG/3-1 ATS Route Network Optimising in the South American Region** That the ICAO SAM States take relevant action to follow the guidelines and meet the target dates established in the ATS Route Network Optimising Programme in the South American Region that appears in Appendix B to this part of the report. (Action adopted in SAM/IG/2) Optimize the airspace structure, reorganizing the red or implementing new routes based on strategic objectives of the airspace, taking into consideration "airspace modelling", ATC simulations (accelerated time and/or real time), life trials, etc.	See action plan from the ATS routes network optimisation programme (Appendix B, Attachment 1 to SAM/IG/3 Meeting Report on Agenda Item 2)	Optimised ATS routes network	As per action plan	States RLA/06/901 IATA Regional Office	RO/ATM RO/AIM	Valid Conclusion and action adopted in SAM/IG/2 are oriented towards achieving the same results. The Action plan was updated (see Appendix B on Agenda item 2 of SAM/IG/4.

No.	Task to be developed	Specific tasks	Deliverables	Finalization date	Responsible	Supporting members to the task	Status of implementation
2-2	Prepare the preliminary evaluation of airspace safety	Collect necessary data. Carry out safety assessment applying the methodology adopted.	PBN will be implemented showing that agreed safety levels will be kept or maintained	SAM/IG/5	CARSAMMA	RO/ATM	Valid SAM/IG/3 agreed that safety assessment should be based in a qualitative analysis through the use of SMS
2-3 Prev 2-15	Flexibility in special use airspace.	ANSPs will Establish coordination mechanism with military authorities Discuss matters such as location, altitudes, and validity periods of special use airspaces.	Obtain the efficient use of the airspace in terms coordinated and agreed between civil and military authorities, contemplating the benefit of all users	SAM/IG/4	States	N/A	Valid Global civil/military coordination forum (October 2009) A civil/military seminar/ workshop will be required for 2001 in the SAM Region

No.	Task to be developed	Specific tasks	Deliverables	Finalization date	Responsible	Supporting members to the task	Status of implementation
2-4 Prev 2-16	Handling of air transport environmental problems	Obtaining of objective data over benefits that will be reached in terms of reduction of harmful gas emissions into the atmosphere.	Known data Availability of information required for monitoring of environmental protection.	SAM/IG/5	States	N/A	Valid. Check fuel savings estimate chart.
2-5	Prepare a measurable plan of performance, including gas emissions safety, efficiency, etc.	Check available tools to carry out this task Prepare a measurable plan	A measurable plan will be available which will permit a clear vision of the current and future status of performance regarding gas emissions, safety and efficiency	SAM/IG/5	RLA/06/901	RO/ATM	Valid. This task was included in the optimisation programme of the action plan.

No.	Task to be developed	Specific tasks	Deliverables	Finalization date	Responsible	Supporting members to the task	Status of implementation
2-6	**Conclusion SAM/IG/3-2 Data Collection** That SAM States: a) collect data on all flights carried out in the SAM Region upper airspace (FL 245 or above) in national and international routes in the period **1-31 July 2009** and send them to the SAM Regional Office before **30 September 2009.** b) use a sample consistent with the **form and the instructions for completing the form**, contained in **Attachment 2 to Appendix B** to this part of the report, using the EXCEL format.	The Secretariat should send a letter to States States should collect information as agreed. States should send information to the Regional Office. Information received must be assessed	A data base containing – - movement in ATS routes per FIR - movement between pairs of cities, - peak hours - movement in TMA - FL most used - air operators and type of aircraft used.	SAM/IG/5	Regional Office States RLA/06/901	RO/ATM RO/AIM CARSAMMA	Completed Letter LT 2/3A.13-LN 3/24.6.1-SA364 dated 8 June 2009 Except for French Guyana and Suriname, all States replied this survey.
2-7	Determine entry/exit points of main TMAs in the SAM Region	States shall determine entry/exit points of main TMAs Shall present information at SAM/IG/4	Adequate information will be available to prepare Version 1 of ATS routes network	SAM/IG/4	States	RO/ATM	Completed States informed that they will not carry out changes in their TMA. Except Brazil and Guyana shall reply on March 2010.

No.	Task to be developed	Specific tasks	Deliverables	Finalization date	Responsible	Supporting members to the task	Status of implementation
2-8	Determine and obtain necessary tools for the development of Version 1 of routes network (aeronautical charts, specific software)	Evaluate necessary tools	Basic elements will be available for the development of Version 1 of ATS routes network	SAM/IG/5	SAM PBN RLA/06/901	RO/ATM	Valid Flight Star available.
2-9	Interphase between ATS routes network of the CAR and SAM Regions	Evaluate interphase options in the ATS routes network in the CAR and SAM Regions	Develop Version 1 of ATS routes network to respond to users requirements	SAM/IG/5	SAM PBN TF Regional Office	RO/ATM	Valid Harmonize lower boundary of CAR and SAM Routes.
2-10	Carry out a detailed study of the ATS routes network, with a view to prepare Version 1 of routes network (ref 2.2.2 of the Action plan of the ATS routes optimization programme of the SAM Region.	Carry out a workshop among SAM experts, in order to review and validate the study of item 2.2.5 of the action plan of the ATS routes optimization programme of the SAM Region.	Initial draft of proposal Version 1 of routes network ready	March 2010	RLA/06/901 Regional Office IATA	RO/ATM	Valid. Will be presented at the RCC RLA/06/901 to obtain support from 3 persons to make a study. Will invite IATA and operators to select one person to assist in the development of the task.

No.	Task to be developed	Specific tasks	Deliverables	Finalization date	Responsible	Supporting members to the task	Status of implementation
2-11	Prepare safety assessment required applying a qualitative methodology through the use of SMS (Ref 2.2.3 of the Action Plan – Programme for optimisation of the ATS Routes Network of the SAM Region)	Carry out safety assessment	Version 1 of ATS routes network will be implemented; demonstrating that agreed safety level will be maintained or improved.	October 2010	RLA/06/901	RO/ATM CARSAMMA	Valid

No.	Task to be developed	Specific tasks	Deliverables	Finalization date	Responsible	Supporting members to the task	Status of implementation
3. Implementation of Performance Based Navigation (PBN) in the SAM Region							
3-1 Prev. 1-1	**SAM/IG/1-1 CAR/SAM PBN Roadmap** That ICAO SAM States, in implementing RNAV/RNP, take the pertinent actions to follow guidelines contained in the CAR/SAM PBN Roadmap as shown in Appendix C to this part of the report.	Shall facilitate implementation at a regional level Each State should comply with the actions agreed in the PBN Roadmap	States will have a National en-route, TMA and APP PBN implementation Plan.	SAM/IG/3	States	N/A	Completed. States adopted the PBN roadmap.
3-2 Prev. 2-3	**Conclusion SAM/IG/2-1 PBN implementation Programme for en-route operations** That the ICAO SAM States take appropriate actions to follow the guidelines and comply with the targets established in the PBN implementation for en-route operations, which is shown in **Appendix B** to this part of the Report.	Execution of the action plan	RNAV 5 implemented in the SAM Region	SAM/IG/6	PBN focal points of the States.	RO/ATM	Valid.

No.	Task to be developed	Specific tasks	Deliverables	Finalization date	Responsible	Supporting members to the task	Status of implementation
3-3 Prev. 2-14	**Conclusion SAM/IG/2-4 PBN Implementation Model for TMA and Approach** That States/Territories and International Organizations use the PBN Implementation Model for TMA and Approach in the preparation of their PBN implementation programmes for TMA and Approach, shown in **Appendix E** to this part of the Report.	Prepare action plans for PBN implementation in TMA and approach	Action plans accompanying regional implementation	SAM/IG/4	PBN focal points of the States	RO/ATM	Valid.
3-4	Evaluate regulations for the use of GNSS, and if such were the case, proceed to its publication	Review information available.	All SAM States with regulations for the use of GNSS available	SAM/IG/3	Secretariat	RO/CNS	Completed

No.	Task to be developed	Specific tasks	Deliverables	Finalization date	Responsible	Supporting members to the task	Status of implementation
3-5 Prev. 1-1	**Conclusion SAM/IG/3-3 PBN Implementation National Plans** That States of ICAO South American Region, present their PBN Implementation National Plans to SAM/IG/4 Meeting, using PBN Implementation Plan Model, shown in Appendix B of this part of the Report, as well as using the action plan models and information contained PBN Implementation Project TMA Operations and Short Term Approximations of SAM Region, approved by SAM/IG/2 Meeting.	Prepare national PBN plans	All SAM States will have a PBN implementation plan aligned with the regional PBN plan	SAM/IG/4	States	RO/ATM	Valid 8 States in the SAM Region presented a draft national PBN plan for its harmonization. After the analysis, it was agreed that all PBN national plans must be submitted to the ICAO SAM Regional Office as of 31 December 2009.

No.	Task to be developed	Specific tasks	Deliverables	Finalization date	Responsible	Supporting members to the task	Status of implementation
3-6 Prev. 2-12	**Conclusion SAM/IG/2-3 Survey on the Fleet Navigation Capacity** That States conduct a survey on the fleet navigation capacity, using, to that end, the form contained in **Appendix D** to this part of the Report, and send the information collected to the ICAO South American Regional Office, on the following dates: a) Aircraft operating commercial flights, which have more than 5 700 kg. of MTOW – 15 February 2009	States must carry out this survey. Secretariat should upload Form of SAM/IG/2 Appendix 2 on Agenda item 2.	Fleet navigation capacity flying in the SAM Region	It was re-programmed and unified the date for delivery of literals a), b) and c) until 31 July 2009	Focal points designated by States RO	JF/OQ/ MU/VCH	Completed regarding a) Valid. b) and c)
3-6 Prev. 2-12	b) Aircraft operating commercial flights, which have less than 5 700 kg. of MTOW – 15 May 2009; c) Other aircraft registered in the Region – 15 August 2009.						

No.	Task to be developed	Specific tasks	Deliverables	Finalization date	Responsible	Supporting members to the task	Status of implementation
3-7	Analyse aircraft fleet navigation capacity	Prepare data base	Aircraft fleet capacity analysed	SAM/IG/4	RLA/99/901	VCH	Completed regarding a) Pending b) and c).
3-8 Prev. 2-13	Collect air traffic data to understand air traffic flows in a specific airspace.	States shall collect air traffic flow data	States will have a clear view of the type of traffic operating in a specific airspace	SAM/IG/4	States PBN focal points	JF/AO	
3-9	Analyse communications, navigation means and surveillance (VOR, DME) ground to attend navigation specifications and reverse navigation	Prepare a CNS data base	Navigation specification and reverse navigation mode	SAM/IG/5	Regional Office SIP RLA/06/901	Brazil/ Chile RO/ATM	Valid. CNS Task A partial report was presented at SAM/IG/4.

No.	Task to be developed	Specific tasks	Deliverables	Finalization date	Responsible	Supporting members to the task	Status of implementation
3-10	Design procedures training - RNP Approach with required authorization (AR)	Prepare SIP to have FAA instructors	Experts from States duly qualified in RNP, APCH AR matters	SAM/IG/4	Regional Office SIP RLA/06/901	Brazil/Chile RO/ATM	**Completed.** RNAV/RNP courses were dictated: RNAV/RNP and ARNP AR APCH. Brazil and Chile provided the instructors. Support was obtained from a SIP and from Regional Project RLA/06/901 for the participation of the students.

No.	Task to be developed	Specific tasks	Deliverables	Finalization date	Responsible	Supporting members to the task	Status of implementation
3-11 Prev. 2-10	**Conclusion SAM/IG/2-2** **Initial AIC** That States of ICAO SAM Region using as model the AIC presented in Appendix C to this part of the Report: a) publish in the AIRAC date of 9 April 2009 an Aeronautical Information Circular (AIC) informing the aeronautical community on their intention to implement RNAV 5 on 18 November 2010; b) reflect in this AIC the specific situations within the airspace under their jurisdiction.	Prepare AIC Publish AIC	Aeronautical community duly informed on States plans for RNAV 5 implementation.	SAM/IG/5	States	RO/ATM RO/AIM	Partially implemented: at 23 October 2009, French Guyana, Guyana, Panama, Suriname had not implemented yet.

No.	Task to be developed	Specific tasks	Deliverables	Finalization date	Responsible	Supporting members to the task	Status of implementation
4. Standards and procedures for performance based navigation operations approval							
4-1	Analyse aircraft approval requirements and operators (pilots, dispatchers, and maintenance personnel) as established in PBN manual, and develop necessary documentation. Note: See Agenda Item 3, SAM/IG/2 and SAM/IG/3 Agenda Item 4.	Develop LAR with regard to PBN approvals	Guidelines at States disposal	SAM/IG/3 SAM/IG/4	Regional Project RLA/06/901	JF/OQ MU/VCH	Valid In charge of RLA/99/901. CAs were completed on RNAV 10, RNAV 5, RNAV 1 and 2, Basic RNP 1, RNP APCH, RNP AR APCH and APV Baro VNAV. A new working plan has been established for the development of the CA on RNP4, RNP2 and RNP1, in progress.

No.	Task to be developed	Specific tasks	Deliverables	Finalization date	Responsible	Supporting members to the task	Status of implementation
4-2	**Conclusion SAM/IG/3-4 Advisory Circulars CA 91-008, CA 91-009 and CA 91-010** That States of the SAM Region: a) use as acceptable means of compliance in aircraft approval and exploiters for RNP APCH, RNP AR APCH and APV/baro-VNAV operations, Advisory Circulars CA 91-008, CA 91-009 and CA 91-010, shown in **Appendices B, C and D,** respectively to this part of the report; and b) publish the corresponding national regulations until **5 October 2009**.	Develop the procedures related to aircraft and users approval regarding RNP, APCH, RNP AR APCH and APV/Baro-VNAV operations	National regulation ready for approval of aircraft and users	SAM/IG/4	States Regional Project RLA/06/901	JF OQ MU VCH	Valid. Replaced by Conclusion SAM/IG/4-2

No.	Task to be developed	Specific tasks	Deliverables	Finalization date	Responsible	Supporting members to the task	Status of implementation
5-1 Prev 4-2	**Conclusion SAM/IG/2-6 ATFM Roadmap** That, a) the ATFM Roadmap in **Appendix B** to this part of the Report be adopted, with the aim of providing orientation to the ATFM community with regard to ATFM applications to be implemented in the short and medium term in the SAM Region; and b) the ICAO Secretariat send the ATFM Roadmap to the GREPECAS ATFM Task Force for the analysis and actions deemed pertinent.	States must adopt ATFM Roadmap sheet and inform on the intentions to national aeronautical community	Aeronautical Community in knowledge of regional and national activities related to ATFM ATFM roadmap shall be presented to the ATFM/5 Meeting	SAM/IG/3	States ATFM Focal points ATFM Rapporteur	ATFM Rapporteur/ JF/AO	Completed.
5-2	Carry out the tasks to be developed by Regional Project RLA/06/901. See SAM/IG/3 Report	Hire experts through Regional Project RLA/06/901	Tasks identified by the meeting to be executed by Regional Project RLA/06/901 carried out.	SAM/IG/4	RLA/06/901 Experts	JF/OQ	**Completed**
5-3 Prev 4-5	Publish initial AIC ATFM using the model prepared by SAMIG	States publish AIC	Community informed on States plans regarding ATFM		States	JF	Completed. Except for Suriname.

No.	Task to be developed	Specific tasks	Deliverables	Finalization date	Responsible	Supporting members to the task	Status of implementation
5-4	ATFM Manual – First Part	Continue developing ATFM manual	States will have a manual for its harmonized application in the SAM Region	SAM/IG/4	RLA/06/901 Expert	JF/AO	Completed (SAM/IG/4-WP/10)
5-5	**Conclusion SAM/IG/3-5 Runway capacity of an international airport and ATC associated sector** SAM States are encouraged to carry out at least an exercise to determine the runway capacity of an international airport and ATC sector, associated or another one selected for each State, to present the results to the SAM/IG/4 Meeting, providing the following information: a) Amount of personnel trained for the exercise b) Methodology applied c) Result of the exercise, providing the declared capacity for each runway and ATC selected sector. d) Identification of problems found in the methodology applied.	Carry out estimate capacity in an airport and its associated ATC sector	States shall put into practice the course dictated on this matter and shall obtain the necessary experience to evaluate capacity at a national level.	SAM/IG/4	States	JF	Valid Bolivia, Brazil, Colombia, Paraguay, Peru and Venezuela presented its preliminary exercise.

No.	Task to be developed	Specific tasks	Deliverables	Finalization date	Responsible	Supporting members to the task	Status of implementation
5-6	Guidance document for the application of a common methodology for the estimation of airport capacity and ATC sectors for the SAM Region	Prepare a guidance document for the application of a common methodology for the estimation of airport capacity and ATC sectors for the SAM Region	States will have a guide for the application of a common methodology for the estimation of airport capacity and ATC sectors for the SAM Region	SAM/IG/4	RLA/06/901 Expert	JF/AO	Completed (SAM/IG/4-WP/05)

APPENDIX B

FOLLOW-UP OF CONCLUSIONS AND PENDING TASKS OF THE SAM/IG MEETING

Conclusión/Tarea Conclusion/Task	**ARG**	**BOL**	**BRA**	**CHI**	**COL**	**ECU**	**FGY**	**GUY**	**PAN**	**PAR**	**PER**	**SUR**	**URU**	**VEN**	**OBSERVACIONES REMARKS**
1-1 **SAM/IG/1-1** **CAR/SAM PBN Roadmap** That ICAO SAM States, in implementing RNAV/RNP, take the pertinent actions to follow guidelines contained in the CAR/SAM PBN Roadmap as shown in **Appendix C** to this part of the report.	**YES**	**YES**	**YES**	**YES**	**YES**	**O/G**	**--**	**YES**	**O/G**	**YES**	**O/G**	**YES**	**YES**	**YES**	
1-1 That States examine: a) Impact of RNAV routes implementation in t he airspace Aircraft fleet, Air traffic services, and b) Establish pertinent coordination so as to enable integrated, harmonious and timely implementation of more direct RNAV routes.	**O/G**	**O/G**	**O/G**	**O/G**	**O/G**	**O/G**	**--**	**O/G**	**O/G**	**O/G**	**O/G**	**O/G**	**YES**	**O/G**	**COL:** June **ECU**: Local coordination with corresponding area. **PAR:** SAMIG 5 **PER**: Dec 2009 **VEN:** Mar.2010
2-1 Implementation of RNAV routes	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**--**	**YES**	**YES**	**YES**	**O/G**	**YES**	**YES**	**O/G**	**ECU:** Missing pronouncement of VEN in regard of the effective date for the implementation of the route Guayaquil / Madrid**.**

Conclusión/Tarea Conclusion/Task	**ARG**	**BOL**	**BRA**	**CHI**	**COL**	**ECU**	**FGY**	**GUY**	**PAN**	**PAR**	**PER**	**SUR**	**URU**	**VEN**	**OBSERVACIONES REMARKS**
2-3 **Conclusion SAM/IG/2-1 PBN implementation Programme for en-route operations** That the ICAO SAM States take appropriate actions to follow the guidelines and comply with the targets established in the PBN implementation for en-route operations, which is shown in **Appendix B** to this part of the Report.	**YES**	**YES**	**YES**	**YES**			**--**	**YES**	**YES**	**YES**	**O/G**	**YES**	**YES**	**YES**	
2-10 **Conclusion SAM/IG/2-2 Initial AIC** That States of ICAO SAM Region using as model the AIC presented in Appendix C to this part of the Report: a) publish in the AIRAC date of 9 April 2009 an Aeronautical Information Circular (AIC) informing the aeronautical community on their intention to implement RNAV 5 on 18 November 2010; b) reflect in this AIC the specific YEStuations within the airspace under their jurisdiction.	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**--**	**O/G**	**O/G**	**YES**	**YES**	**O/G**	**YES**	**YES**	**GUY**: Oct.22,2009 **SUR:** Will inform Nov.15,2009

Conclusión/Tarea Conclusion/Task	ARG	BOL	BRA	CHI	COL	ECU	FGY	GUY	PAN	PAR	PER	SUR	URU	VEN	OBSERVACIONES REMARKS
2-12 Conclusion SAM/IG/2-3 Survey on the Fleet Navigation Capacity That States conduct a survey on the fleet navigation capacity, using, to that end, the form contained in **Appendix D** to this part of the Report, and send the information collected to the ICAO South American Regional Office, on the following dates: a) Aircraft operating commercial flights, which have more than 5 700 kg. of MTOW – 15 February 2009; b) Aircraft operating commercial flights, which have less than 5 700 kg. of MTOW – 15 May 2009; c) Other aircraft registered in the Region – 15 August 2009.	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**--**	**YES**	**O/G**	**NO**	**YES**	**O/G**	**YES**	**YES**	
2-13 1.2 1.2 Collect air traffic data to understand air traffic flows in a specific airspace	**YES**	**NO**	**YES**	**YES**	**YES**	**YES**	**--**	**YES**	**O/G**	**YES**	**YES**	**YES**	**YES**	**YES**	

Conclusión/Tarea Conclusion/Task	ARG	BOL	BRA	CHI	COL	ECU	FGY	GUY	PAN	PAR	PER	SUR	URU	VEN	OBSERVACIONES REMARKS
2-14 Conclusion SAM/IG/2-4 PBN Implementation Model for TMA and Approach That States/Territories and International Organizations use the PBN Implementation Model for TMA and Approach in the preparation of their PBN implementation programmes for TMA and Approach, shown in **Appendix E** to this part of the Report	**YES**	**O/G**	**O/G**	**YES**	**O/G**	**YES**	**--**	**YES**	**O/G**	**YES**	**O/G**	**O/G**	**YES**	**O/G**	**ECU**: Developing **PER:** SAM/IG/4 **SUR**: Nov.15, 2009 **VEN**: March 2010
2-15 Flexibility in special use airspace.	**O/G**	**O/G**	**O/G**	**OG**	**O/G**	**O/G**	**--**	**O/G**	**N/A**	**O/G**	**YES**	**O/G**	**YES**	**O/G**	**CHI:** They have a committee responsible for these subjects **ECU:** Will require information at SAM/IG/3 **PAN:** Panama does not have army nor air force. **VEN:** Undetermined
2-16 Handling of air transport environmental problems	**O/G**	**NO**	**O/G**	**YES**	**NO**	**NO**	**--**	**O/G**	**O/G**	**O/G**	**O/G**	**O/G**	**YES**	**NO**	**ECU**: Example: Chile SAM/IG/5 **PER**: SAM/IG/5 **BOL**: SAMIG/6

Conclusión/Tarea Conclusion/Task	ARG	BOL	BRA	CHI	COL	ECU	FGY	GUY	PAN	PAR	PER	SUR	URU	VEN	OBSERVACIONES REMARKS
3-1 **Conclusion SAM/IG/2-5** **Advisory Circular CA 91-002 and** **Job Aid for Aircraft and operators** **RNAV 5 operational *approval*** That States of ICAO South American Region: a) Use as an acceptable compliance source in aircraft and operators RNAV 5 operational approval Advisory Circular CA 91-002 and Job Aid for Aircraft and operators RNAV 5 operational approval, presented in **Appendices A** and **B**, respectively, to this part of the Report. b) Publish respective national regulations up to April 2009.	**YES**	**NO**	**O/G**	**O/G**	**YES**	**O/G**	**--**	**O/G**	**O/G**	**NO**	**O/G**	**O/G**	**O/G**	**O/G**	**ECU**: Coord. with OPS **PAR:** Developing **PER**: Dec 2009
4-2 **Conclusion SAM/IG/2-6** **ATFM Roadmap** That, a) the ATFM Roadmap in **Appendix B** to this part of the Report be adopted, with the aim of providing orientation to the ATFM community with regard to ATFM applications to be implemented in the short and medium term in the SAM Region;	**O/G**	**O/G**	**O/G**	**O/G**	**YES**	**O/G**	**--**	**O/G**	**O/G**	**YES**	**O/G**	**O/G**	**YES**	**O/G**	**ECU:** ATFM **PER:** Dec.2009 **VEN:** Jul.2010

Conclusión/Tarea Conclusion/Task	ARG	BOL	BRA	CHI	COL	ECU	FGY	GUY	PAN	PAR	PER	SUR	URU	VEN	OBSERVACIONES REMARKS
and b) the ICAO Secretariat send the ATFM Roadmap to the GREPECAS ATFM Task Force for the analyses and actions deemed pertinent															
4-5 Manual ATFM AIC	**YES**	**YES**	**N/A**	**O/G**	**YES**	**YES**	**--**	**YES**	**O/G**	**O/G**	**YES**	**O/G**	**YES**	**O/G**	**ECU:** AIC published **COL:** June **GUY:** 22 Oct 2009 **PAR:** In Publishing process **URU**: AIC published 07 May 2009 **VEN:** Mar.2010

Instrucciones para el llenado del formulario - Instructions to fill in the form

- Cumplida: colocar **Sí** en el casillero correspondiente. / Accomplished: place **YES** in the corresponding box
- En ejecución: colocar **O/G** (on going) e indicar en "observaciones" la fecha prevista de término./ In execution: place **O/G** (on going) and indicate under "remarks" the estimated deadline
- No cumplida: colocar **NO** en el casillero correspondiente y, de ser el caso, hacer comentarios en columna de observaciones/ Not complied: place **NO** in the corresponding box and if such were the case, make comments in the remarks column

APPENDIX C

FOLLOW-UP TO CONCLUSIONS ON CNS IMPROVEMENTS

Conc/Dec Strategic Objective	Title of Conclusion/ Decision	Text of Conclusion/Decision	Follow-up Action	To be initiated by	Status	Deliverable	Target date
SAM/IG 1-5 D	Adoption of Action Plan Models for the improvement of communications and surveillance systems for en-route and terminal area operations	When carrying out activities for the improvement of communications and surveillance systems for en-route and terminal area operations, the action plan models are to be taken into account for the improvement of ground-air, ground-ground communications and surveillance systems being presented as **Appendices D, F and I** to the report of this agenda item.	Implementation of action plan for improvement of ground-air communications. Implementation plan for improvement of ground-ground communications systems. Implementation plan for improvement of surveillance systems.	SAM States/ Territory and ICAO SAM Regional Office	Valid Valid Valid	Improvement of the communications, navigation and surveillance systems	Mar 2012 Dec 2012 Dec 2015

Conc/Dec Strategic Objective	Title of Conclusion/ Decision	Text of Conclusion/Decision	Follow-up Action	To be initiated by	Status	Deliverable	Target date
SAM/IG 3-5 D	State implementation plans for improving CNS systems in the short and medium term	That, taking into account the guide for the improvement of CNS systems to meet the short- and medium-term operational requirements for en-route and terminal area operations developed by Project RLA/06/901 and reviewed by the SAM States/Territory (Appendix A to report on Agenda Item 5) and the action plan model for CNS improvements, in Appendix A to this part of the Report, SAM States draft an action plan for the improvement of CNS systems and, once completed, the plans be sent to the ICAO South American Regional Office before **28 August 2009**.	Letter SA276 of 4 May 2009 was sent requesting States to draft the action plan for CNS improvements in the short and medium term. Letter of reminder SA602 was sent on 1 September 2009.	ICAO SAM Regional Office	Completed All SAM States, with the exception of Colombia, French Guiana and Panama presented their their action plans for required CNS improveme nts	SAM States action plans on CNS improvements in the short and medium term	28 August 2009

Conc/Dec Strategic Objective	Title of Conclusion/ Decision	Text of Conclusion/Decision	Follow-up Action	To be initiated by	Status	Deliverable	Target date
SAM/IG 3-6 D	Interconnection of AMHS Systems in the SAM Region	That, in order to start implementing the interconnection of automated systems in the SAM Region: a) the SAM States/Territory take note of the AMHS addressing structure in Appendix B to this Agenda Item, when implementing AMHS systems: - review the router implementation plans, the ATN ground-ground applications in Appendix D to SAM/IG/2-WP/19 and present their results to the ICAO Regional Office by 29 May 2009; - review the Guide for the implementation of national digital networks in IP protocol to support current and future aeronautical applications in Appendix E to SAM/IG/2-WP/19 and present their comments by 30 June 2009;	Letter SA277 of 4 May 2009 was sent to SAM States requesting the information required through Conclusion SAM/IG/3-6 Guide for the interconnection of AMHS systems drafted	ICAO SAM Regional Office Mission of CNS expert	Completed Completed	SAM Region AMHS addressing plan duly updated. SAM Region router implementation plan and ATN ground applications duly updated Guide for the interconnection of AMHS systems	31 July 2009 30 September 2009

Conc/Dec Strategic Objective	Title of Conclusion/ Decision	Text of Conclusion/Decision	Follow-up Action	To be initiated by	Status	Deliverable	Target date
		b) Project RLA/06/901 elaborate a guide for the interconnection of AMHS system, by 31 July 2009; and c) SAM States, upon implementing the automated system interconnection, use the guidance documents prepared by project RLA/06/901.					

APPENDIX D

FOLLOW-UP TO CONCLUSIONS ON AUTOMATED SYSTEMS

Conc/Dec Strategic Objective	**Title of Conclusion/ Decision**	**Text of Conclusion/Decision**	**Follow-up Action**	**To be initiated by**	**Status**	**Deliverable**	**Target date**
SAM/IG 3-7 D	Updating of SCID Document	In order to update the SICD document, prepared in 2007: a) States of the SAM Region included in the SICD, are encouraged to review and update the information contained in the document; b) Any State of the Region having automated systems not included in the SICD, should send the information to the ICAO South American Regional Office; and c) The information requested in a) and b) above, should be sent to the ICAO South American Regional Office, not later than 29 May 2009.	The ICAO SAM Regional Office sent the information required to the SAM States/Territory	ICAO SAM Regional Office and SAM States/Territory	Completed	Updated SICD document	30 June 2009

Conc/Dec Strategic Objective	Title of Conclusion/ Decision	Text of Conclusion/Decision	Follow-up Action	To be initiated by	Status	Deliverable	Target date
SAM/IG 3-8 D	Preparation of specific implementation plans for the interconnection of automated systems	That States of the SAM Region start the development of specific plans for the implementation of automated systems interconnection, considering the implementation dates indicated in Regional Interconnection Plan for Automated Systems in adjacent ACCs, specified in Appendix B of this part of the Report, and information contained in the following documentation: a) Memorandum of Understanding for the implementation of automated systems interconnection between two States having adjacent ACCs, Interface Control Document (ICD) for data communication between ATS dependencies in Caribbean and South American Regions (CAR/SAM ICD); b) Interface control document (ICD) for data communications between ATS units in the Caribbean and South American Regions (CAR/SAM ICD); c) System Interface Control Document (SICD); and d) Regional interconnection initial plan for ACC automated systems. e) Preliminary reference system/ subsystem specification for the air traffic control automation system (SSS).	To date, as follow-up to the action plan for the implementation of automated systems between SAM pairs of States, Argentina-Uruguay, Argentina-Brazil and Brazil-Uruguay have drafted and signed MoUs for the interconnection of their automated systems.	SAM States	Valid	Memorandum of Understanding (MoU) between SAM pairs of States for the interconnection of automated systems	2012

Agenda Item 2: Optimization of the ATS routes structure

RNAV Routes Implementation

2.1 The Meeting took note on the status of implementation of RNAV routes that were approved during SAM/IG/3 Meeting, as well as of other routes that were revised and agreed to be implemented during bilateral or multilateral Meetings.

2.2 **Appendix A** contains the list of routes in the process of implementation and comments when justified.

2.3 In this respect, the Meeting was of the opinion that from this Meeting, RNAV routes should not be implemented independently, taking into consideration that the SAM Region ATS routes network optimization programme has as main objective to achieve an inter-functional air traffic management, available to all users during all flight phases, which complies with the agreed safety levels and provide economically optimum operations, be sustainable with regard to the environment, and meets national aviation safety requirements. In view of the above, States and users were requested to analyse new routes within the framework of such optimisation programme.

Programme for the Optimization of ATS Routes Structure

2.4 The Meeting reviewed the program for the optimization of the South American Region ATS Routes Network, and the associated action plan, which includes tasks to be undertaken by responsible people with established deadlines.

2.5 The result of this review is shown in **Appendix B** to this part of the report.

2.6 In assessing activity 2.2.3 – Determine the entry and exit points of the main TMA of the Region, it could be noted that the following States do not foreseen changes in their main TMAs up to March 2010: Argentina, Bolivia, Chile, Colombia, Guyana, Paraguay, Peru, Suriname, Uruguay and Venezuela. Brazil is analysing this possibility and shall inform it as appropriate. Venezuela has the intention to implement a TMA in Guayana and has a plan to implement one in Valencia, Base Libertador. In the case of Guyana, an improvement is being programmed in the Georgetown TMA, before the second half of 2010. In November 2010 Peru could possible make some changes in their TMAs.

2.7 With regard to activity 2.2.4 on the Necessary tools to carry out this study, different mechanisms were mentioned, such as the 3D Autocad-map which permits to geo-referent routes. It is a versatile tool that might sustain the work to be carried out. Other tools were evaluated, such as MAPSOURCE. Summarising, the necessary tools are not defined yet and investigations will continue in this connection.

2.8 As per activity 2.2.5, the Meeting concluded that it would be necessary that each State designates a point of contact which should be available during a three-week of thorough study to the SAM routes network, to deliver the necessary information for the development of the experts group work, through email, telephone or similar means. In this connection, the Meeting formulated the following Conclusion:

Conclusion SAM/IG/4-1 - SAM routes network point of contact

That SAM States designate a point of contact to support the development of task 2.2.5 of the Action Plan for optimisation of the SAM Routes Network, and send the corresponding data (email and telephone) until 31 January 2010.

Preliminary Analysis of Air Traffic Data Compilation

2.9 The Meeting noted that, unless for French Guyana and Panama, all States sent to the Secretariat, air traffic data collection from 1 to 31 July 2009 in their respective areas of responsibility. In coordination with CARSAMMA it was agreed that all this information collected shall be analysed initially by the regional agency, to be then delivered to the Secretariat, so that Regional Project RLA/06/901 may carry out a further analysis.

2.10 During the revision of this matter, the preliminary analysis that is being carried out by Brazil was done and note was taken that the work carried out by Brazil could reach to some conclusions that might be similar to other States in the Region.

2.11 The preliminary analysis of available data from the FIR Brasilia, Curitiba and Recife, has indicated that, given the outstanding types of in 90% of the sample, 89% of flights could, in principle, be approved for RNAV-5.

2.12 Also, in the preliminary analysis of city pairs served in the Brazilian FIRs, it was identified that there is a significant number of city pairs involved in the provision of ATS. Therefore, it was initially concluded that version 1 of the route network will have to use the concept of Trunk Routes, seeking to include several pairs of cities with one route, considering, moreover, the need to prioritize the highest volume of air traffic, as identified in the RNAV routes implementation process in the Region.

2.13 In relation to flight levels, a high concentration in levels RVSM (between FL 290 and 410) of approximately 94% was observed. That way it is possible to verify that a possible exclusionary airspace, combined with the navigation capability of the fleet, could be used by a significant portion of users that operate in the upper airspace.

Flexible Use of Airspace (FUA)

2.14 The Meeting recognized that flexible use of airspace is a concept of airspace management, serving optimisation, balance and fairness in the use of airspace between civil and military users, facilitated through strategic coordination and dynamic interaction between both parties.

2.15 Taking into account that there are activities that require the reservation of a volume of airspace for their exclusive or special use (SUA) for defined periods of time, due to the characteristics of its flight profile or to the risks involved in the operations to be performed in such volume and to the need to effectively and securely separate them from other types of aviation activities, the Uruguayan administration presented a draft FUA Regulation and a regulation framework. The draft project is presented at Appendix D to Report on Agenda Item 5, since it could serve as a reference to other States.

IATA Report on User Requirements for Air Traffic Services

2.16 The Meeting noted that the first edition of the IATA report on users requirements for air traffic services considers technologies that are widely available or under consideration to provide Communications, Navigation and Surveillance (CNS) for Air Traffic Management (ATM). The structure consists of a brief technology description followed by IATA's position on implementation. Recommendations are based on the evaluation of operational benefits, e.g. schedule, safety, efficiency, cost, risk, and availability.

2.17 The document is meant to serve as a planning tool and represents the consolidated view of IATA's members, which comprise some 230 of the world's leading passenger and cargo airlines representing 93 percent of scheduled international air traffic.

2.18 In general, IATA's position on short to mid term CNS/ATM infrastructure improvements is to maximise the existing capabilities that are on aircraft today and to support the implementation of the following technologies, among others, where operationally feasible, in consultation with airlines:

a) Speech communications migrating to a data link based communication as the primary means of controller-pilot communication while continuing the provision of voice communication as a backup and for non-routine communications.

b) Performance Based Navigation (PBN), supported by GNSS as the primary navigation means for all flight phases.

c) ATS Surveillance mainly based on ADS-B and when required supplemented with Multilateration (MLAT) as the next generation replacement to radar. Additionally, ADS-C should be the common means of surveillance in oceanic airspace.

2.19 With regard to the PDC, the Meeting examined this matter and proposed DCL as an appropriate mechanism for digital clearances.

2.20 The Meeting agreed that this document is included as **Appendix C** to this part of the report, with a view to serve as a reference for the development of future works of the SAM Implementation Group.

APPENDIX A

Montevideo - Buenos Aires

Uruguay has not yet arranged these airspace sectors nor implemented CNS improvements already planned for this route. In view of the above, the proposed implementation of this route is pending.

UM 662 Guayaquil – Madrid

Within the Civil/Military coordination, Venezuela continues coordination with the Venezuelan Air Force a trajectory within the Venezuelan airspace. The resulting trajectory of this coordination shall be informed to the ICAO SAM Regional Office during the first quarter of 2010.

UM 527 Lima – Madrid

States involved have agreed that the date for implementation of this route shall be 27 August 2009, with effective implementation date 24 September 2009. The following trajectory is agreed (See Appendix A to Agenda Item 1):

ESPACIO AÉREO SUPERIOR / UPPER AIRSPACE Lima – Madrid UM 527		
Designador Designator	**Latitud Latitude**	**Longitud Longitude**
Lima VOR	S12°00'30'	W077 07'22''
SIGOB	S08°28'16''	W073°20'18''
AKTOR	S04°00'34''	W068°44'13''
MULIP	S02°29'53''	W067°12'10''
AKNOV	S00°50'33''	W065°20'47''
DOBDA	N04° 32'18.59''	W060°07'49.87''
TIM VOR	N06°29'53''	W058°15'46''
UMREM	N07°56'06.73''	W057°00'03.66''
TRAPP	N09°05'06''	W055°59'30''

Santiago – Sao Paulo

To this respect, and based on a proposal by Brazil, the Secretariat shall coordinate an RNAV route between Córdoba VOR (Argentina) and Paranagua (Brazil), to serve the request presented by IATA as regards the availability of a route between the cities of Santiago (Chile) and Sao Paulo (Brazil). This route will be incorporated into the Version 1 of routes optimisation programme. (See Appendix A to Agenda Item 1)

Note: before the first quarter of 2010.

Santiago – Miami

From coordination carried out by Chile, Peru and IATA it was agreed to evaluate the following trajectory:

Santiago – UL 302 up to VOR LIMA – VOR CHACHAPOYA – KORBO – BOKAN **-** VOR LA PALMA – CIEGO DE AVILA – URSUS-

Comparison of distances:

UL 780: (Santiago – URSUS) 3.521 NM

Trajectory proposed: 3. 504 NM

According to the trajectory under study, coordination shall continue with States involved and IATA, in order to agree the definitive route and proceed to its implementation in the pertinent time and manner.

Note: In case during the first quarter of 2010 the agreement has not been concreted, this trajectory shall be incorporated to the SAM Region ATS routes network optimisation programme.

ATS Pending routes

As agreed in the SAM/IG/2 meeting, ad-hoc groups composed by IATA and States involved would carry out the necessary revisions of routes with pending coordination, as shown in the following chart:

Following are the conclusions adopted in the reference meeting:

ROUTE	REMARKS
UL 306	Coordination pending among BRAZIL, FRENCH GUYANA and SURINAME.
UM782 **UL201** **UA317**	Brazil shall inform on the resulting modifications on the realignment of these routes.
UA307	*States involved, Argentina, Brazil and Chile, agreed to incorporate this matter in the Feasibility Study for the Programme for Optimising the ATS Routes Network in the South American Region* ***(See Appendix A)*** ARGENTINA, BRAZIL, IATA
San José (C. Rica) – Santo Domingo	IATA will coordinate with the NACC Regional Office and CAR States. SAM Regional Office shall coordinate with ATA, Colombia and Panamá

RNAV ROUTE MONTEVIDEO–EUROPE UM 661

The administrations of Brazil and Uruguay agreed on the implementation of a new two-way RNAV route UM 661 to join Montevideo with Europe through the EUR/SAM Corridor. In addition to enabling flights with a shorter trajectory, this route clears high density traffic terminals of the Curitiba and Brasilia FIRs, joining the same from the position ERETU at the South Atlantic, with multiple-entry routes to Europe.

The publication of this route **UM 661** was coordinated for **11 March 2010,** with **applicable date 6 May 2010.**

Main Coordinates:

CRR	34º 49’ 57.8’’ S/ 056º 01’ 30.5’’ W
KILUM	34º 21’ 13’’ S/ 055º 01’ 38’’ W
TODAX	33º 23’ 17’’ S/ 053º 46’ 02’’ W
DAKIS	33º 13’ 28’’ S/ 053º 31’ 12’’ W
KONDU	30º 59’ 57’’ S/ 050º 18’ 20’’ W
ERETU	03º 07’ 42’’ N / 028º 48’ 00’’ W

RNAV ROUTE BRASILIA/ BUENOS AIRES UM 532

The Brazilian and Uruguayan administrations agreed on the implementation of a two-way new RNAV Route **UM532**, to join Brasilia/Buenos Aires through the points CUARA and KUKEN. The publication of this route **UM 532** was coordinated for **11 March 2010, with applicable date 6 May 2010.** As of the reporting point CUARA up to KUKEN, the route is coincident with **UL 324**.

Routes Rosario/Porto Alegre and Route Montevideo/Asunción

These routes proposed by Uruguay consider significant fuel savings and improvement of the environment and in this connection, the administrations of Brazil and Paraguay agree to implement the same as soon as possible, when the Argentinean administration finishes the works being carried out by its airspace-restructuring team.

Note: in case this agreement has not been concreted by the first quarter of 2010, this trajectory shall be incorporated to the to the SAM Region ATS routes network optimisation programme.

Route Córdoba/Porto Alegre

This route is incorporated into the to the SAM Region ATS routes network optimisation programme.

Route from the VAS VOR in the Asunción FIR up to BRS VOR in the Brasilia FIR UM 403

The administrations of Brazil and Paraguay agreed on the implementation of a two-way RNAV route **UM 403** in points VAS VOR in the Asunción FIR and BRS VOR in the Brasilia FIR. This route shall provide significant fuel savings and environment improvement to the route Asunción/ Brasilia.

Main coordinates:

VOR VAS	25º 14’ 39’’S/ 057º 31’ 19’’ W
ILSUD	23º 24’ 23’’ S/ 055º 30’ 53’’W
VOR BRS	15º 52’ 29’’ S/ 048º 01’ 17’’ W

The publication of this route UM 403 was coordinated for **11 March 2010, with applicable date 6 May 2010.**

Route from position LIMPO in the Amazónica FIR up to position APARE in the La Paz FIR UM 784

This route shall provide significant fuel savings and environment improvement to the route Panamá/Buenos Aires.

Main coordinates:

LIMPO	04º 53’36’’ S / 072º 22’ 00’’ W
KILEV	10º 58’ 54’’ S /069º 06’ 04’’ W (FIR boundaries)
APARE	16º 50’ 27’’ S / 065º 48’ 36’’ W

The publication of this route **UM 784** was agreed for **11 March 2010, with applicable date 6 May 2010.**

Deleted routes

The meeting decided to eliminate route **UA 309** from Montevideo to Porto Alegre, and consequently it will be published through AIRAC for **11 March 2010, with applicable date 6 May 2010.**

It was also decided to eliminate route **UB 695** from Asunción up to URUBUPUNGA (Curitiba FIR), and consequently will be published through AIRAC, 56 days after implementation of route **UM 403** foreseen for **6 May 2010.**

APPENDIX B (REVISED)

PROGRAMME FOR OPTIMISING THE ATS ROUTE NETWORK IN THE SOUTH AMERICAN REGION (GPIs 1, 5, 7, 8, 10, 11)

Activity	Start	End	Responsible party	Observations
1. **Phase One – RNAV-5 Implementation**				
1.1. RNAV-5 implementation in the SAM Region	**Apr 2008**	**Nov 2010**	**Regional Project RLA/06/901**	The implementation will be carried out according to the Implementation Programme approved at the SAM/IG/2 meeting
2. **Phase Two – Implementation of Version 1 of the SAM ATS Route Network**				
Activity	**Start**	**End**	**Responsible party**	**Observations**
2.1. Conduct a Feasibility Study for Optimising the SAM Route Network	March 2009	Apr 2009	Regional Project RLA/06/901	Completed
2.2. Airspace Concept				
2.2.1 Collect traffic data to understand air traffic flows	June 2008	SAM/IG/4	SAM/PBN/IG (Project RLA/06/901) States	Completed The Secretariat sent a request to States: Re. LT 2/3A.13-LN 3/24.6.1-SA364 DATED 8 June 2009. Deadline for reply: September 2009 Except for French Guyana and Panama, all SAM States sent the data collection
2.2.2 Analyse the fleet navigation capacity	June 2008	SAM/IG/4	SAM/PBN/IG (Projects RLA/06/901 and RLA/99/901) States-IATA	Completed Task 1.3 of the RNAV-5 Implementation Project Data base in progress

Activity	Start	End	Responsible party	Observations
2.2.3 Determine the gateways of the main TMAs in the SAM Region	SAM/IG/3	SAM/IG/4	States	Completed Argentina, Bolivia, Chile, Colombia, Guyana, Paraguay, Peru, Suriname and Venezuela. Brazil, and Guyana shall inform o March 2010.
2.2.4 Determine and obtain the necessary tools to make the study mentioned in item 2.2.5 (aeronautical charts, specific software)	SAM/IG/3	SAM/IG/4	SAM/PBN/IG (Project RLA/06/901)	Flight Star.(Verify if the acquisition of another software is necessary)
2.2.5 Make a detailed study of the SAM ATS route network, with a view to preparing version 1 of the route network, including the following: • Indicate the domestic and international ATS routes that should be eliminated, in accordance with their use; • Propose the volume of exclusionary airspace for RNAV-5 application • Indicate the “conventional” RNAV routes that should be eliminated or replaced by RNAV routes in the exclusionary RNAV-5 airspace. • Indicate the RNAV routes that should be realigned, in accordance with the gateways of the main SAM TMAs (see 2.2.3). • Describe in detail the proposed new SAM route network, based on the analysis of the aforementioned items. • Describe in detail the interface between the SAM route network and the CAR route network. • Propose the initial draft Proposal of Amendment to the CAR/SAM ANP • Prepare a performance measuring plan	SAM/IG/4	March 2010	SAM/PBN/IG (Project RLA/06/901)	This task requires the hiring of three experts to develop the study. This requirement will be presented to RCC Meeting of RLA/06/901. 3 persons for a period of three weeks. IATA and operators would be invited to select one person to assist in the development of this task.

Activity	Start	End	Responsible party	Observations
including gas emissions safety, efficiency etc.				
2.2.6 Prepare safety assessment required, applying a qualitative methodology through the use of SMS	April 2010	October 2010	Project RLA/06/901	This task requires the hiring of one expert in order to perform the assessment required, applying SMS.
2.2.7 Hold the Workshop of Experts from the SAM States to review and validate the study made under item 2.2.5 and 2.2.6.	SAM/IG/5	June 2010	SAM/PBN/IG (Project RLA/06/901) States	This task requires RCC Meeting authorization in order to count with the support of RLA/06/901. Later to SAM/IG/5
2.3 Implementation of Version 1 of the SAM ATS Route Network				
2.3.1 Process the proposal of amendment to the CAR/SAM Air Navigation Plan	TBD		SAM Regional Office	Shall depend on the decisions to be adopted by the routes workshop of 2.2.6
2.3.2 Publish version 1 of the SAM ATS Route Network	TBD		States	Shall depend on the decisions adopted in the routes workshop of 2.2.6.
2.3.3 Entry into effect of version 1 of the SAM ATS Route Network	TBD			

Activity		Start	End	Responsible party	Observations
3.	**Phase Three – Implementation of Version 2 of the SAM ATS Route Network**				
Activity		**Start**	**End**	**Responsible party**	**Observations**
3.1.	**Flexible Use of Airspace**				
3.1.1.	Develop guidance material for the application of the Flexible Use of Airspace concept, including: • Model for using non-permanent routes similar to that applied in EUROCONTROL (Conditional Routes – CDR). • Criterion for defining scenarios in which non-permanent routes are applied • Criterion for categorising non-permanent routes • Harmonised publication of non-permanent routes • Representation of non-permanent routes in aeronautical charts	SAM/IG/5	SAM/IG/6	SAM/PBN/IG (Project RLA/06/901)	
3.1.2.	Establish the Civil-Military Coordination Committee to evaluate application of the Flexible Use of Airspace concept mentioned in 3.1.1.	SAM/IG/6	SAM/IG/7	States	The Civil/Military Committees should be implemented in those States which have not done so. Plan Civil/Military Meeting/Workshop in 2011.
3.1.3.	Develop proposals for route implementation and/or realignment, in keeping with the utilisation of FUA	SAM/IG/6	SAM/IG/7	States	See 3.1.2
3.2.	**Airspace Concept**				
3.2.1.	Collect traffic data to understand air traffic flows	SAM/IG/6	SAM/IG/7	SAM/PBN/IG (Project RLA/06/901) States	

Activity	Start	End	Responsible party	Observations
3.2.2. Analyse the fleet navigation capacity	SAM/IG/6	SAM/IG/7	SAM/PBN/IG (Projects RLA/06/901 and RLA/99/901) States IATA	
3.2.3. Determine the gateways of the main TMAs in the SAM Region	SAM/IG/6	SAM/IG/7	States	
3.2.4. Determine the necessary tools for making the study mentioned in item 3.2.5 (aeronautical charts, specific software)	SAM/IG/6	SAM/IG/7	SAM/PBN/IG (Project RLA/06/901)	
3.2.5. Make a detailed study of the SAM ATS route network with a view to developing version 2 of the route network, including: • Definition of scenarios for the SAM airspace structure, including ATS routes, control sectors, TMA interface, for assessment using airspace modelling and fast-time ATC simulation tools. • Indicate the ATS routes that should be eliminated in accordance with their utilisation; • Propose, if necessary, the extent of exclusionary airspace volume for RNAV-5 application • Indicate, as necessary, the “conventional” ATS routes that should be eliminated or replaced by RNAV routes in accordance with the possible extension of the exclusive RNAV-5 airspace volume. • Indicate the RNAV routes that should be realigned in keeping with possible modifications to the gateways of the main TMAs in the SAM Region. • Detail possible scenarios for version 2 of the SAM route network and of control sectors, based on the analysis of the previous items	SAM/IG/7	June 2011	SAM/PBN/IG (Project RLA/06/901)	

Activity		Start	End	Responsible party	Observations
	• Detail the interface between the SAM route network and the CAR route network • Propose the initial draft Proposal of Amendment to the CAR/SAM ANP.				
3.2.6.	Prepare a safety assessment and routes spacing	SAM/IG/7	July 2011	CARSAMMA	Quantitative assessment in order to determine spacing between routes to be applied in item 3.2.5
3.2.7.	Make Airspace Modelling and Fast-Time Simulation studies to assess the scenarios developed in 3.2.5	August 2011	SAM/IG/9		
3.2.8.	Hold the Workshop of Experts from the SAM States to review and validate the studies made in items 3.2.5, 3.2.6, and 3.2.7.	SAM/IG/9	June 2012	Project RLA/06/901 States	
3.3.	**Implementation of Version 2 of the SAM ATS Route Network**				
3.3.1.	Process the proposal of amendment to the CAR/SAM Air Navigation Plan	TBD		SAM Regional Office	
3.3.2.	Publish version 1 of the SAM ATS Route Network	TBD		States	
3.3.3.	Entry into effect of version 2 of the SAM ATS Route Network	TBD			

APPENDIX C

IATA

USER REQUIREMENTS FOR AIR TRAFFIC SERVICES

User Requirements for Air Traffic Services

Effective 8 May 2009

1st Edition

infrastructure@iata.org

Foreword

Dear Reader,

There are times when airlines are taken by surprise from announcements of new equipment for air traffic control being purchased that, as far as airlines are concerned, holds little promise of benefit. In most of these cases, airlines and other airspace users were not consulted during the planning process and the technology was bound to disappoint.

Such misadventures are costly to everyone and are a waste of scarce funding. Regrettably, such undesirable situations continue to occur today, when waste can be ill afforded by the air transport industry.

On the other hand, successful procurement projects are invariably associated with a planning and consultation process that draws upon input from representatives of the airspace users, as well as equipment manufacturers and neighbouring States. Such planning also helps airlines schedule their own investments in aircraft technology to work in synch with new air navigation services equipment, leading to clear operational benefits.

Based on a thorough understanding of airspace user requirements and capabilities, these projects are far more successful in providing much-needed benefits to airspace users in terms of increased safety, on-schedule operations and cost efficiency.

We have prepared this report to offer a better understanding of international airlines' requirements and capabilities for communications, navigation, surveillance and air traffic management.

Best regards,

Günther Matschnigg,
Senior Vice President
Safety, Operations & Infrastructure
International Air Transport Association

IATA Report on User Requirements for Air Traffic Services

Executive Summary

IATA has prepared this report to offer guidance to Air Navigation Service Providers (ANSPs), States, vendors and funding organizations on international airline infrastructure requirements for air traffic services between now and the 2020 timeframe.

This report considers technologies that are widely available or under consideration to provide Communications, Navigation and Surveillance (CNS) for Air Traffic Management (ATM). The structure consists of a brief technology description followed by IATA's position on implementation. Recommendations are based on the evaluation of operational benefits, e.g. schedule, safety, efficiency, cost, risk, and availability.

This document is meant to serve as a planning tool and represents the consolidated view of IATA's members, which comprise some 230 airlines as of December 2008 – the world's leading passenger and cargo airlines among them - representing 93 percent of scheduled international air traffic.

In general, IATA's position on short to mid term CNS/ATM infrastructure improvements is to maximise the existing capabilities that are on aircraft today and to support the implementation of the following technologies where operationally feasible, in consultation with airlines:

- Voice migrating to data link as the primary means of controller-pilot communication while continuing the provision of voice communication as a backup and for non-routine communications.
- Performance Based Navigation (PBN), enabled by GNSS as the primary radio navigation aid for all phases of flight.
- Surveillance based primarily on Automatic Dependent Surveillance Broadcast (ADS-B) and when required supplemented with Multilateration (MLAT) as the next generation replacement to radar. Additionally, Automatic Dependent Surveillance Contract (ADS-C) should be the common means of surveillance in oceanic airspace.

The following table summarizes IATA's position on current CNS/ATM Infrastructure technologies and applications, while figures 1-3 offer suggested timelines for the commissioning of the newer technologies and the decommissioning of the older technologies.

Summary: IATA's Positions on CNS / ATM Infrastructure

Technologies & Applications		IATA's Position		
		Support where justified	**Maintain during transition**	**Do NOT support or support in limited cases**
COMMUNICATIONS	AFTN		X	
	AMHS	X		
	VSAT	X		
	AIDC	X		
	VHF Voice 8.33 KHz Channel Spacing	X		
	HF Voice	X		
	SatCom	X		
	IRIDIUM	X		
	HFDL	X		
	ACARS	X		
	VDL Mode 2	X		
	VDL Mode 3			X
	VDL Mode 4			X
	CPDLC	X		
	ATN	To be Determined		
NAVIGATION	PBN	X		
	WGS-84	Essential		
	DME	X		
	ILS	X		
	MLS			X
	NDB			X
	TACAN			X
	VOR		X	
	GNSS	X		
	ABAS	X		
	GBAS	X		
	SBAS			X
SURVEILLANCE	PSR			X
	SSR Mode A/C		X	
	SSR Mode S	X		
	PAR			X
	ADS-B OUT	X		
	ADS-B IN	X		
	ADS-C	X		
	TIS-B		X	
	MLAT	X		
CANDIDATE ADS-B DATA LINKS	1090 ES	X		
	VDL Mode 4			X
	UAT			X
OTHER DATA LINK SERVICES	D-ATIS	X		
	AWOS	X		
	PDC	X		

Infrastructure should have timelines for commissioning and decommissioning. An approximate transition roadmap through the 2020 timeframe is depicted in figures 1 through 3 and table 1.

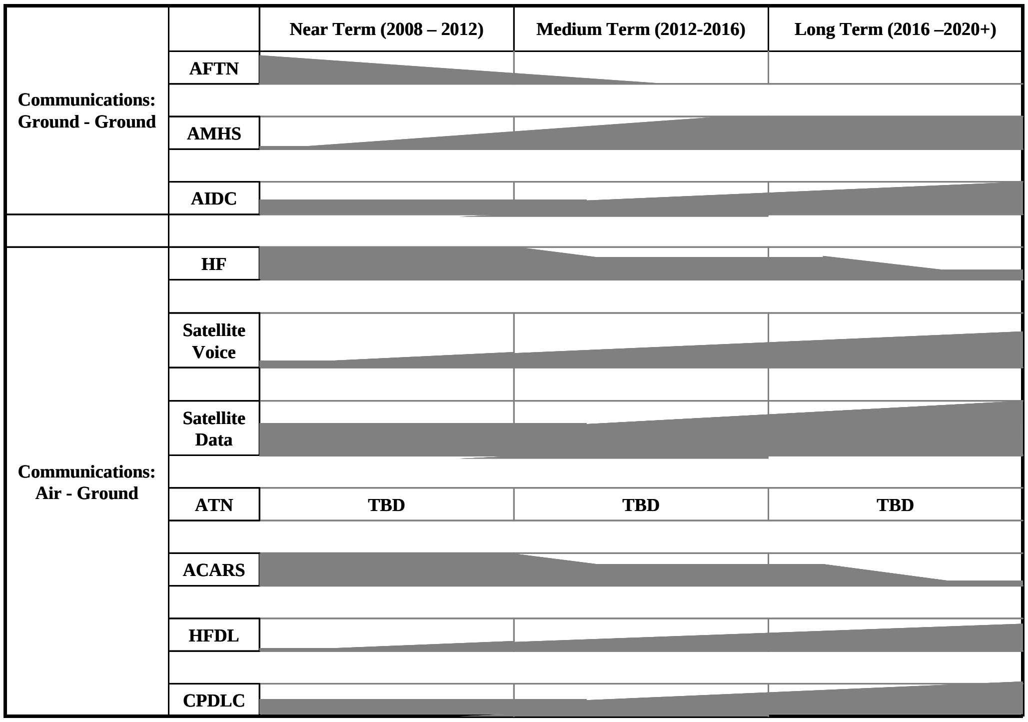

Figure 1. Communications Roadmap (present – 2020)

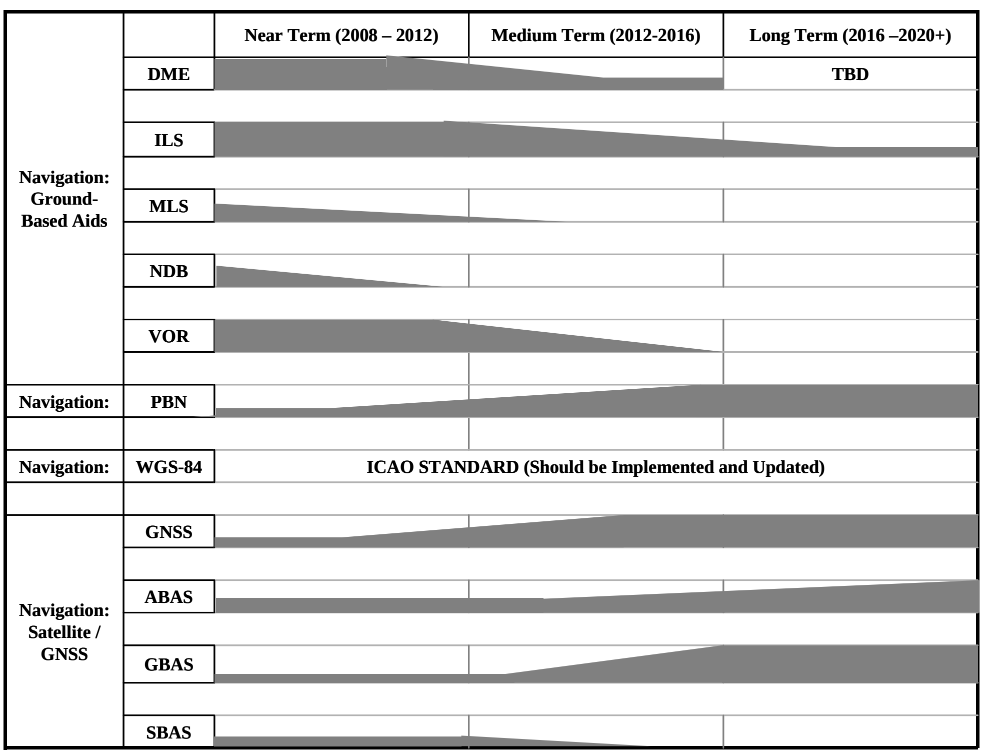

Figure 2. Navigation Roadmap (present – 2020).

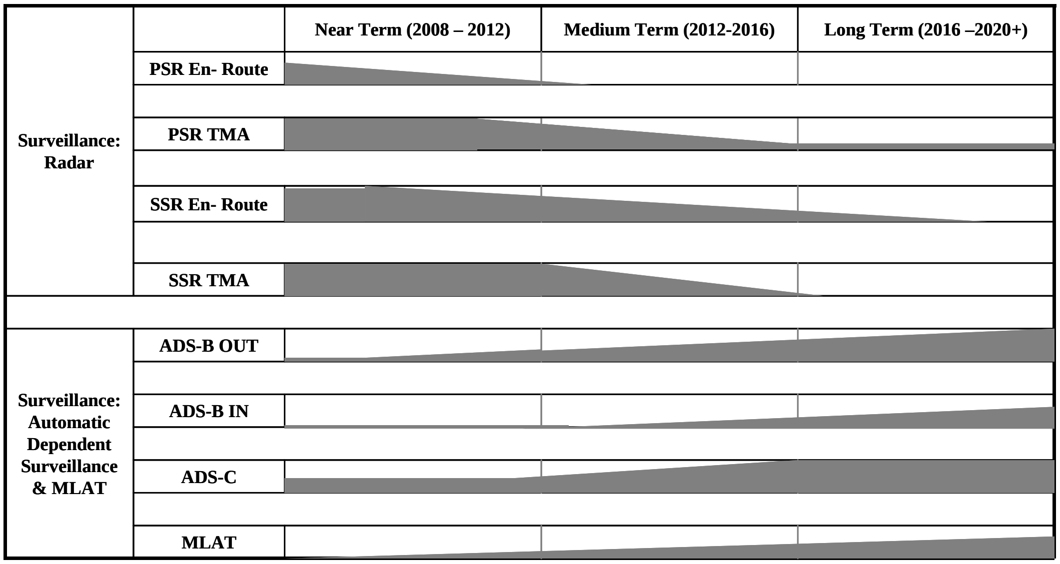

Figure 3. Surveillance Roadmap (Present – 2020)

Table 1. Surveillance Technologies (2020 approximate time frame)

	Oceanic / Remote	**En-Route Continental**	**Terminal Area**	**Surface Monitoring**
Primary	ADS-C / ADS-B	ADS-B	ADS-B or MLAT	ADS-B or MLAT
Backup	Procedural Control	MLAT	MLAT	MLAT or ADS-B

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1. Ground-to-Ground Communications

Ground-ground communications refer to exchanges of messages concerning planning and movement of aircraft between ATS units and with other aeronautical or military organizations. Such communications are moving from analogue to digital format and are becoming increasingly automated.

Technologies and applications reviewed in this section include:
- Aeronautical Fixed Telecommunications Network (AFTN) and ATS Message Handling Services (AMHS)
- Very Small Aperture Terminal (VSAT) and
- Air Traffic Services Interfacility Data Communications (AIDC)

1.1 Infrastructure

1.1.1 Aeronautical Fixed Telecommunications Network (AFTN) and ATS Message Handling Services (AMHS)

The AFTN is a message-handling network that has existed for over 40 years. It is a closed network in the sense that its users belong to ATS authorities and associated organizations such as airline operators, general aviation, and meteorological offices.

The AFTN is character-based only and cannot meet the need to carry bit-oriented applications.

The aviation industry has adopted AMHS to replace the AFTN. The AMHS can carry digital information such as text, graphics, images, files, databases, audio and video. ICAO has specified standards to ensure interoperability between AMHS and AFTN during the migration period.

IATA's Position:

IATA supports a rapid decommissioning of AFTN and replacement by AMHS. Interoperability during transition must be ensured by interconnecting legacy AFTN terminals to the AMHS.

1.1.2 Very Small Aperture Terminal (VSAT)

The VSAT is a ground station that uses satellites to relay voice and data from small terminals to other terminals. VSATs are typically used for communications between ATC centers in areas where leased circuits are unreliable or uneconomical.

VSAT ground station terminals on a shared network are versatile, economical and scalable, whereas the deployment of new VSAT networks is considerably more expensive.

IATA's Position:

Support deployment of VSAT station terminals where operationally justified, as they offer a versatile, economical, and scalable solution for ground-to-ground aeronautical communications. However, proliferation of VSAT networks, which are considerably more expensive, should be avoided where existing ones, both national and international, can be expanded to serve new areas.

1.2 ATS Application

1.2.1 Air Traffic Services Interfacility Data Communication (AIDC)

AIDC is a ground-ground data link communication service that provides the capability to automatically exchange data between ATS units for notification, coordination and transfer of aircraft between flight information regions (FIRs). AIDC message format and procedures is an international standard designed for use through any ground-ground circuit, including the legacy AFTN.

AIDC greatly reduces the need for voice coordination between ATC facilities, resulting in fewer errors and reduced workload.

IATA's Position:

Support AIDC deployment as the primary means of coordination between ATC facilities, while maintaining the capability for controllers to intervene via voice for non-routine communications.

2. Air-to-Ground Communications

Controller-pilot communications use primarily voice links provided by analog radios operating in the VHF and HF bands. Aviation is moving towards a new communications infrastructure that will provide superior communication through use of air-ground data link. A first generation of ATC applications was implemented using Aircraft Communications Addressing and Reporting System (ACARS) air-ground data links. ACARS now needs to transition to modern communications protocols (e.g. VDL Mode 2) in order to support increasing user traffic and provide the performance needed for ATS.

The objective is to adopt data link as the primary means of communication while maintaining the requirement for voice communications as a backup and for non-routine communications.

This section overviews the following technologies and applications:

- VHF Voice 8.33 KHz Channel Spacing
- High Frequency (HF Voice)
- Satellite Communications (SatCom)
- IRIDIUM
- Aeronautical Telecommunications Network (ATN)
- VHF Data Link (VDL) Mode 3
- Aircraft Communications Addressing and Reporting System (ACARS)
- High Frequency Data Link (HFDL)
- VHF Data Link (VDL) Mode 2
- Controller Pilot Data Link Communications (CPDLC)

2.1 Infrastructure

2.1.1 VHF Voice 8.33 KHz Channel Spacing

VHF analog radios use channels of varying bandwidth. Since aircraft started using VHF radios, progress in radio technology has enabled the channel bandwidth to be reduced from 100 kHz down to 8.33 kHz.

In March 2007, the ICAO European Region made the carriage and operation of 8.33 kHz radios mandatory above FL195.

***IATA's Position*:**

Support implementation of 8.33 kHz channel spacing only in regions where 25 KHz channel spacing does not provide an adequate number of frequencies. Where implemented, carriage of 8.33 kHz-capable radios should be mandatory to ensure that all potential safety and capacity benefits are realized.

2.1.2 High Frequency (HF) Voice

HF voice is used for air-ground ATC communications in remote and oceanic areas outside the range of VHF frequencies. In most cases, an HF radio operator functions as an intermediary between controllers and pilots, transcribing and relaying the contents of HF voice communications.

Aircraft can use radios operating in the HF radio band for long-range communications because signals are reflected by the ionosphere. Link quality and availability are variable, and influenced by a number of factors, including frequency congestion, sunspot activity, the eleven-year solar cycle, and day/night ionospheric conditions.

Data communication can reduce the current congestion of HF voice traffic, and therefore improve HF voice communication services.

IATA's Position:

Support data link as the primary means of communication for oceanic and remote areas while continuing to provide HF voice service as a backup. Ground based HF transceivers should be equipped with Selective Calling (SELCAL).

2.1.3 Satellite Communications (SatCom)

Satellite communications for the provision of air traffic services in oceanic and remote airspace are primarily offered through a constellation of 11 INMARSAT geosynchronous orbit (GEO) satellites and associated Ground Earth Stations (GES) operated by independent telecommunications providers. The INMARSAT satellite network offers voice and data services except in extreme Polar Regions (above 82' 30'' North). The Japanese MTSAT system offers voice and data services in parts of the Pacific and Asia.

SatCom enables a direct communication channel between pilots and controllers, as opposed to transcribed data messaging where an HF radio operator functions as intermediary. Satellite communications are considered more reliable (although more costly) than HF, which is subject to interference, disruption, and delays due to its exposure to ionospheric and operating conditions.

IATA's Position:

Support SatCom as the data link enabler to allow direct controller-pilot data communications in oceanic and remote areas. Satellite voice for non-routine communications is recommended to reduce HF voice congestion in oceanic and remote areas.

2.1.4 IRIDIUM

The IRIDIUM Satellite Network is a constellation of 66 Low Earth Orbit (LEO) satellites, allowing aircraft to have smaller and lighter avionics than necessary for service via Geo-stationary satellites.

IRIDIUM offers complete earth coverage, including voice and data service in the Polar Regions. Additionally, IRIDIUM can be a good backup for ground-to-ground communications for ATS.

Air transport aircraft are beginning to be equipped with avionics that use IRIDIUM satellites. ICAO is currently working on approval of IRIDIUM for safety of life services by Air Traffic Control. Once approved, there will be airlines using this service.

***IATA's Position*:**

There is a global requirement for satellite data link and voice air-ground communications in airspace outside of VHF coverage (see 2.1.3), including the Polar Regions.

2.1.5 High Frequency Data Link (HFDL)

HFDL is used for air-ground communications in remote and oceanic airspace. Many carriers use HFDL instead of satellite services, or as a backup system. The addition of HFDL communications represents only a small increment in cost for HF equipped aircraft. One drawback of HFDL is that it does not have the communication performance of SatCom data link. However, HFDL provides data-link coverage for polar operations, where GEO based SatCom has no coverage.

***IATA's Position*:**

Support HFDL service availability in oceanic and remote areas, especially in the polar region, while considering that HFDL does not have the communication performance of SatCom data.

2.1.6 Aircraft Communications Addressing and Reporting System (ACARS)

ACARS is a data link technology developed for airlines in the late 1970s for exchange of operational data between their operations centers and aircraft in flight.

Today, ACARS is also used by many ANSPs for controller-pilot-data-link communications (CPDLC) for air traffic control with FANS-1/A aircraft.

Use of ACARS for ATC purposes has reduced workload for controllers and pilots, reduced potential for error inherent in voice communications, and off-loaded congested ATC radio voice channels.

ACARS is available via HF, VHF, and satellite data links.

<u>IATA's Position</u>:

Support upgrade to a full-bit oriented service while continuing to use ACARS as a basis for transition. ACARS is a proven technology that still meets user requirements for aeronautical communications.

2.1.7 VHF Data Link (VDL) Mode 1

ICAO developed VDL Mode 1 based on the ACARS physical layer in an effort to transition from a character-oriented VHF data link to a bit-oriented protocol with higher data integrity. Although ICAO published Standards and Recommended Practices (SARPs) for VDL Mode 1 in 1996, the development of VDL Mode 2 rendered VDL Mode 1 obsolete.

VDL Mode 1 has been withdrawn from ICAO standards.

2.1.8 VHF Data Link (VDL) Mode 2

VDL Mode 2 is an air-ground digital data link that is being introduced as an ACARS upgrade for ATC controller-pilot data communications while still allowing ACARS equipped aircraft to use the same network.

VDL Mode 2 is a bit-oriented system, which means that messages are sent more efficiently. ACARS transmission is limited to letters and numbers, while VDL Mode 2 sends coded data.

VDL Mode 2 delivers data at 31.5 Kbps, which is over 13 times faster than the VHF ACARS 2.4 kbps rate. This is the highest possible bit rate that can be supported by a 25 kHz channel while providing a range of 200 nautical miles. A 250 character block will take about 0.06 seconds to cross the VDL Mode 2 link instead of 0.83 seconds on the ACARS link.

VDL Mode 2 uses the Carrier Sense Multiple Access (CSMA) protocol to detect when a VHF channel is clear in order to avoid overlap with other transmissions. The VDL Mode 2 CSMA technology is superior to that of ACARS, as it detects a clear channel much quicker. This in turn results in reduced message delay and higher success rates under heavy loading conditions.

VDL Mode 2 has been accepted by the industry as the natural upgrade for ACARS.

<u>IATA's Position</u>:

Support upgrade of existing ACARS networks to a more efficient full-bit oriented service via VDL Mode 2.

2.1.9 VHF Data Link (VDL) Mode 3

VDL Mode 3 is a four-channel, digital/analog VHF digital link providing a pipeline for data and digital voice communications. VDL Mode 3 is based on a Time Division Multiple Access (TDMA) protocol, which operates by dividing a single channel into continuous discrete time slots and enabling up to four channels in a single 25 KHz frequency. Users interact with a master control station to mediate access to the channel. TDMA supports the delivery of time-critical messages and non-interfering voice and data transmissions.

VDL Mode 3 data link was proposed to relieve VHF voice channel congestion in the U.S. It faced competition from 8.33 kHz channel spacing, which is already implemented in Europe. Because many airlines have already equipped to 8.33 kHz, the proposal for VDL Mode 3 was withdrawn.

International airlines are against requirements for multiple equipment carriage to serve similar ATS services.

IATA's Position:

Do not support VDL Mode 3 deployment.

2.1.10 VHF Data Link (VDL) Mode 4

VDL Mode 4 is a bit-oriented VHF data link capable of providing air to air and air to ground communications. VDL Mode 4 supports time-critical applications and it is efficient in exchanging short repetitive messages.

VDL Mode 4 is based on the Self-organising Time Division Multiple Access (STDMA) protocol. Through this self-organizing system, the time available for transmission is subdivided into multiple time-slots. Each time slot is planned and reserved for transmission by users' radio transponders within range of each other. This enables efficient data link use and prevents simultaneous transmission from different users. STDMA allows users to mediate access to discrete time slots without reliance on a master control station.

VDL Mode 4 was a data link candidate for ADS-B. However, 1090 MHz Mode S Extended Squitter (ES) has been chosen as the standard for international aviation.

IATA's Position:

Do not support VDL Mode 4 deployment.

2.1.11 Summary VHF Data Links

Table 2 provides a summary on the physical and data communication characteristics of the VHF data links 2.1.7 through 2.1.10.

Table 2. Summary: Comparison VHF Data Links

	VHF ACARS	VDL M2	VDL M3	VDL M4
Voice	No	No	Yes	No
Data	Yes	Yes	Yes	Yes
Spectrum required	25KHz	25 KHz	25 KHz	25 KHz
Data Rate	2.4 Kbps	31.5 Kbps	31.5 Kbps	19.2 Kbps
Protocol Specification	Character - oriented	Bit – oriented May also handle character-oriented messages, uses lower bandwidth	Bit – oriented	Bit – oriented
	Air-to-ground	Air-to-ground	Air-to-ground	Air-to-ground & air-to-air
Media Access Control (MAC)	CSMA	CSMA	TDMA	STDMA
Applications	AOC & ATS comm. (PDC/DCL, ATIS, CPDLC)	Supports CPDLC comm. & graphic weather services.	Digitized voice & data comm. Supports 4 sub-channels within the 25Khz channel	Supports comm., graphic weather service, ADS-B, TIS-B, CDTI, GNSS local area augmentation
IATA Supports	Yes	Yes	No	No

2.2 ATS Application

2.2.1 Controller Pilot Data Link Communications (CPDLC)

CPDLC refers to communications between controllers and pilots using pre-defined message sets, with a free-text option for non-routine messages.

CPDLC is significantly safer and more reliable than voice communications, as it reduces voice errors and misinterpretations, increases clarity, and helps reduce communication delays.

IATA's Position:

Support CPDLC deployment as the primary means of communication in oceanic and remote airspace where the quality of voice communications is often poor. At the same time, CPDLC should be gradually introduced to busier en-route and terminal airspace in order to relieve voice communications.

2.2.2 Aeronautical Telecommunication Network (ATN)

ATN is an internetwork architecture that allows ground, air-ground and avionic data sub-networks to interoperate by adopting common interface services and protocols based on the International Organization for Standardization (ISO) Open Systems Interconnection (OSI) reference model.

During the mid-eighties, the ICAO Future Air Navigation System 1 (FANS 1) Committee recognized the need for aviation to introduce a global data network that would connect those playing a role in air transport such as Air Traffic Control (ATC), pilots, airlines, and military. The methodology chosen was designated the Aeronautical Telecommunication Network (ATN). Shortly thereafter, the aviation industry developed a FANS 1/A[1] data link capability using VHF air-ground stations and communication satellites. Despite its successful implementation, specifically in the Pacific Ocean region, it was not considered an integral part of the ATN.

ICAO started work on standardization of the ATN, based on the Open Systems Interconnect (OSI) seven-layer protocol stack as defined in International Telecommunications Union (ITU) and International Standards Organisation (ISO) specifications. ICAO further developed standards for the interface of Secondary Surveillance Radar (SSR) Mode S data link, Very High Frequency Data Link (VDL) modes 2, 3 and 4, and SatCom air ground data links.

ATN standards for an airborne certifiable ATN/OSI system became available in 2002, by which time the OSI protocol stack was already becoming outdated in the telecommunication industry.

Since 2003, ICAO has endeavoured to transform the ATN into a modern network by specifying use of Internet Protocol (IP) - the same protocol suite used today by the telecommunication industry. This development facilitates an ATN topology in which all relevant parties can be connected whilst at the same time making the physical network transparent to users. The relevant ICAO standards have been adopted by the ICAO Council and became applicable in November 2008.

Consequent to the need for a high quality communication infrastructure in the SESAR and NextGen programmes, a draft communication roadmap has been developed. Table 3 provides a comparison of communication technologies supporting information exchange within SESAR / NextGen.

It should be noted that SESAR divides the transition roadmap toward the year 2020 in three implementation steps IP 1, 2 and 3, while NextGen identifies three phases towards its target year of 2025, level 1, 2 and 3.

[1] FANS 1 is the Boeing designation while FANS A is the Airbus term.

Table 3. NextGen and SESAR Transition Roadmap – Communication Technologies

	Air-Ground	**Ground-Ground**	**Air-Air**
NextGen: Legacy	VHF voice UAT SatCom HF Voice/DL Mode S	Legacy voice switching	1030/1090 ACAS
SESAR: Present	VHF voice SatCom HF Voice/DL Mode S		1030/1090 ACAS
NextGen: Level 1	VDL Mode 2	Analog services, point-to-point digital services and IP network services over a common data transport layer.	ADS-B not addressed as air to air link but only surveillance
SESAR: IP 1	VDL Mode2/ATN	VoIP IP based network	1090 ES (ADS-B OUT)
NextGen: Level 2	VDL Mode 2 Multiple A/G links beyond VHF band	Integrated VoIP, data and Video IP services.	ADS-B not addressed as air to air link but only surveillance
SESAR: IP 2	VDL Mode2/ATN IEEE 802.16(WIMAX-Surface communication)		1090 ES (ADS-B IN/OUT)
NextGen: Level 3	Integrated Ground and Air Network for Voice /Data	Integrated Ground and Air Network for Voice /Data	ADS-B not addressed as air to air link but only surveillance
SESAR: IP3	New L-band Terrestrial and satellite link		L-band link

Under these programmes the following conclusions can be drawn:

a) The projects are specific on the next generation network physical elements and protocols, without being precise on the next steps.
b) Acknowledgment of the need for an increased air-ground data communication capacity, but system selection will be left to system planners.
c) IP protocols are favoured over original ATN specification.
d) Move to voice/data network integration.
e) Aside from identifying the content and evolution of the information to be exchanged, there is very limited data on the measurable Quality of Service parameters (e.g. capacity, latency, integrity, and availability) required to support the operational concept.
f) Issue of VHF congestion due to inefficient voice spectrum utilization is suppressed.
g) Appears to be no clear overall roadmap to a net centric architecture supporting System Wide Information Management (SWIM) services.

Today, the lines between traditional telecommunication services are becoming increasingly blurred due to convergence in the Information Technology (IT) sector. This facilitates a wide range of services over a single, Internet Protocol (IP) based network. Therefore, regarding ATN versus IP, the main question is how fast are we moving and can we go directly to IP without taking the ATN intermediate step? Reasons to directly move to IP are that ATN is an aviation specific solution, meaning that there are no commercial off-the-shelf (COTS) solutions and it has limited backwards compatibility.

In summary, although FANS 1/A and aeronautical telecommunication network (ATN) applications support similar functionality, the avionics requirements are different. There are a little over 350 aircraft today ATN equipped flying in Europe and about 3,000 aircraft that are FANS 1/A equipped, which take advantage of the data link services offered in certain oceanic and remote regions.

IATA's Position

Due to the rapid evolution of telecommunication standards and protocols, further evaluation is required before a final recommendation can be made on the next generation global communication network system.

3. Navigation: Performance Based Navigation (PBN)

Performance-based navigation (PBN) is a global set of area navigation standards, defined by ICAO, based on performance requirements for aircraft navigating on departure, arrival, approach or en-route. These performance requirements are expressed as navigation specifications in terms of accuracy, integrity, continuity, availability and functionality required for a particular airspace or airport. PBN will eliminate the regional differences of various Required Navigation Performance (RNP) and Area Navigation (RNAV) specifications that exist today.

The PBN concept encompasses two types of navigation specifications:

- **RNAV specification**: navigation specification based on area navigation that does not include the requirement for on-board performance monitoring and alerting, designated by the prefix RNAV, e.g. RNAV 5, RNAV 1.
- **RNP specification**: navigation specification based on area navigation that includes the requirement for on-board performance monitoring and alerting, designated by the prefix RNP, e.g. RNP 4.

The 2007 36th ICAO General Assembly resolution A36-23 urges all States to implement PBN for en route and terminal areas, and to implement PBN approach procedures with vertical guidance (APV) using Baro-VNAV and/or augmented GNSS (see section 6.1) for all instrument runway ends (as primary or back-up for precision approach) by 2016 - with 30% by 2010, 70% by 2014.

It is expected that all future navigation applications will identify the navigation requirements through the use of PBN performance specifications, rather than defining equipage of specific navigation sensors. Table 4 gives a more complete description and status of the PBN RNAV and RNP values.

Table 4. PBN Values & Application

Area of Application	Navigation Accuracy (NM)	Navigation Specification (current)	Navigation Specification (new)	Require performance monitoring & alerting
Oceanic & Remote	10	RNP 10	RNP 10	No
	4	RNP 4	RNP 4	Yes
En route – Continental	5	RNP 5 Basic RNAV	RNAV 5	No
En route – Continental and Terminal	2	US RNAV type A	RNAV 2	No
	2	*N/A*	*Basic-RNP 2 (TBD*)*	*Yes*
Terminal	1	US RNAV type B P RNAV	RNAV 1	No
	1	N/A	Basic-RNP 1	Yes
	1	*N/A*	*Advanced RNP 1 (TBD)*	*Yes*
Approach	0.3	RNP 0.3	RNP APCH (RNP 0.3)	Yes
	0.3-0.1	RNP SAAAR	RNP AR APCH (RNP 0.3-0.1)	Yes

* *To be Developed (TBD)*

Benefits

The advantage of PBN to the ANSP is that PBN avoids the need to purchase and deploy navigation aids for each new route or instrument procedure. The advantage to everyone is that PBN clarifies how area navigation systems are used and facilitates the operational approval process for operators by providing a limited set of navigation specifications intended for global use.

The safety benefits to PBN are significant, as even airports located in the poorest areas of the world can have runway aligned approaches with horizontal and vertical guidance to any runway end without having to install, calibrate and monitor expensive ground based navigation aids. Therefore, with PBN all airports can have a stabilized instrument approach that will allow aircraft to land into the wind, as opposed to a tail wind landing.

Airline Requirements

Airlines want to quickly adopt PBN, as the benefits are significant for all phases of flight.

- For departures, airlines want standard instrument departures (SIDs) for every departing runway that quickly allows aircraft to join their route to destination.
- For en-route, airlines ideally want routes that are flexible based on that day's operating conditions and upper winds. If flexible routes are not possible then a network of RNAV or RNP direct routes is preferred.
- For arrivals, airlines want standard arrivals (STARs) off every airway that provides the least track miles to the initial approach fix, preferably with a continuous descent profile from the top of descent.
- For approaches airlines need a runway aligned approach with lateral and vertical guidance (APV) for every runway end that terrain allows.

The decision to plan for RNAV or RNP has to be decided on a case by case basis in consultation with the airspace user. Some areas need only a simple RNAV to maximise the benefits, while other areas such as nearby steep terrain or dense air traffic may require the most stringent RNP. Also, since RNP AR Approaches require significant investment and training, ANSPs should work closely with airlines to determine where RNP AR Approach should be implemented. In all cases PBN implementation needs to be an agreement between the airspace user, the ANSP and the regulatory authorities.

IATA's Position:

Fully support early implementation of RNAV and RNP based on the ICAO PBN. IATA also supports the implementation of Approach with Vertical Guidance (APV) for all runways with a Barometric VNAV used for vertical path guidance during the final approach segment.

During the transition period to PBN, regional specific area navigation requirements should honour PBN navigation approvals that also meet the regional specific criteria. For example, in the European Flight Efficiency Plan there is a provision where all operators that are approved against the PBN criteria for RNAV 1 should be eligible to operate on European P-RNAV routes with no further approval required.

4. Navigation: WGS-84

There are many different geodetic reference datums in use throughout the world that provides reference to terrain and charting. However, for aviation there is only one acceptable standard, which is WGS-84. This ICAO Standard is found in Annexes 4, 11 and 14, which states "World Geodetic System — 1984 (WGS-84) shall be used as the horizontal (geodetic) reference system for air navigation." These requirements became applicable on 1 January 1998.

Consequentially the Global Navigation Satellite System (GNSS) and all aircraft navigation and terrain avoidance systems are based solely on WGS-84. All aircraft systems assume that the latitude and longitude coordinates provided are based on WGS-84. If such charted coordinates are not WGS-84, then there is a positional discrepancy between where the pilot and controller thinks the aircraft is at and the actual position of the aircraft itself. Such a discrepancy is not tolerable and adversely affects the safety of flight, especially at lower altitudes near terrain and obstacles. Therefore, all routes and all instrument procedures must be based upon WGS-84 coordinates.

States that have not implemented WGS-84 are in a serious safety violation and need to implement WGS-84 as soon as possible. Additionally, WGS-84 must undergo periodic maintenance and validation, as terrain and man-made obstacles (whether temporary or permanent) do change.

IATA's Position:

Implementation and maintenance of WGS-84 coordinates is a paramount priority due to consequential safety implications.

5. Navigation: Ground-Based Aids

Conventional navigation aids are ground stations in fixed locations with limited coverage according to their Standard Service Volumes. Aircraft usually calculate their position using radio signals from navigation aids in known locations. This section provides an overview of the following ground-based navigation aids:

- Distance Measuring Equipment (DME)
- Instrument Landing Systems (ILS)
- Microwave Landing System (MLS)
- Non-Directional Beacon (NDB)
- Tactical Air Navigation (TACAN)
- VHF Omni-directional Range (VOR) stations

5.1 Distance Measuring Equipment (DME)

The DME is a ground-based navigation aid that measures distance between an aircraft and a ground station by timing the propagation delay of radio signals.

DME has been considered a cost effective contingency navigation system to GNSS, and it is also part of the navigation infrastructure that supports Performance Based Navigation.

IATA's Position:

Support continued DME deployment where required as a contingency navigation system to GNSS and in accordance with an agreed airspace concept.

5.2 Instrument Landing System (ILS)

The ILS is a ground-based precision landing system that provides horizontal and vertical guidance to an aircraft approaching a runway. ILS is the primary international non-visual precision approach system approved by ICAO, serving the industry for over 40 years and undergoing a number of safety related improvements to increase its accuracy and reliability.

IATA's Position:

ILS is a proven technology that meets user requirements today and is still considered an essential navigation system where precision approaches are required. When the Ground Based Augmentation System (GBAS) becomes a viable option for CAT II/III approaches, then there should be a transition to replace ILS with GNSS Landing System (GLS).

5.3 Microwave Landing System (MLS)

The MLS is a ground-based precision landing system operating in the microwave spectrum. MLS was intended to be the next generation precision approach system that would replace ILS. MLS has the potential to enable closely spaced auto-land approaches in low visibility conditions, as it does not suffer from broadcast interference problems like ILS. Additionally, MLS enables curved approaches through its ±60 degrees of lateral coverage from the runway.

Although some MLS systems became operational in the 1990s, widespread application never occurred due to the introduction of GPS. Consequentially the majority of airlines did not equip. Although there is some renewed interest in Europe, most of the aviation world is waiting to see if GBAS will be able to provide cost effective CAT II/III services to replace ILS (target date for CAT II / III ICAO Standards is 2013).

IATA's Position:

ANSPs / States should only consider MLS implementation at specific aerodromes and these should be limited to places where the airspace users are willing and able to equip and fund for its installation.

5.4 Non-Directional Beacon (NDB)

The NDB is a ground-based navaid that broadcasts non-directional signals, which permit equipped aircraft to determine bearing to or from radio beacon. NDBs were the basis of early air route systems and are used as non-precision approach aids for NDB instrument approaches.

Many of the NDBs in service today are deemed to be obsolete and not required for safe navigation in a navigational infrastructure utilizing GNSS.

IATA's Position:

Support transition to GNSS as the primary radio navigation aid and recommend rapid decommission of NDBs for navigation services. Additionally, airports that only have a non-precision NDB approach should develop a RNAV or RNP approach that meets ICAO's PBN criteria.

5.5 Tactical Air Navigation (TACAN)

TACAN is a ground-based navigation aid used primarily by the military for en-route, non-precision approaches and other military applications. It provides azimuth in the form of radials and distance from the ground station.

IATA's Position:

There are no civil aviation requirements for TACAN.

5.6 VHF Omni-directional Range (VOR)

VOR is a navigation aid that transmits very high frequency navigation signals 360° in azimuth. VOR is the basis for the VHF airway structure and is used for VOR non-precision instrument approaches.

The majority of VORs are over 30 years old and are becoming difficult to maintain. Several ANSPs have indicated a reduced reliance on VORs and are planning their withdrawal as they transition to a Performance Based Navigation (RNAV and RNP) environment.

IATA's Position:

Support transition to GNSS as the primary radio navigation aid and recommend a target date of 2016 for the withdrawal of all VORs. Additionally, airports that only have a non-precision VOR approach should develop an RNP approach that meets ICAO's PBN criteria.

6. Navigation: Global Navigation Satellite System (GNSS)

Navigation is evolving from ground based navigation aids to satellite based navigation systems called the Global Navigation Satellite System (GNSS). GNSS provides standardized positioning information to the aircraft for precise navigation globally. Satellites in the core constellations broadcast a timing signal and a data message. Aircraft GNSS receivers use these signals to calculate their range from each satellite in view and also calculate 3-D position and precise time. Airlines are urging States to move from the current ground-based navigation systems to GNSS that is capable of being used in all airspace during all phases of flight.

As of 2008, the United States NAVSTAR Global Positioning System (GPS) is the only fully operational GNSS used by airlines. However, the Russian GLONASS is currently being restored to full operation (20 satellites by 2009) and the European Galileo global navigation system is scheduled to be operational in 2013. Other future GNSS candidates include China's COMPASS navigation system (potential of 35 satellites) and India's Regional Navigational Satellite System (IRNSS).

GNSS is the ideal radio navigation aid to allow full exploitation of the global benefits to be gained from RNAV and RNP. IATA member airlines have expressed support for GNSS as the primary radio navigation aid for positioning and timing in the future, allowing navigation to migrate from an inefficient fragmented terrestrial system to an efficient GNSS based global air navigation system.

***IATA's Position*:**

Support GNSS as the primary radio navigation aid for all phases of flight.

6.1 GNSS Augmentation

To meet required performance for the more stringent navigational applications, such as precision approaches, augmentation of the GNSS signal is required in order to improve accuracy and monitor data integrity.

The following sections present an overview of IATA's positions on:

- 6.1.1 Aircraft Based Augmentation System (ABAS)
- 6.1.2 Ground Based Augmentation System (GBAS); and
- 6.1.3 Satellite Based Augmentation System (SBAS)

ICAO has published Standards and Recommended Practices (SARPs) for all three of these augmentation systems.

6.1.1 Aircraft Based Augmentation System (ABAS)

ABAS is a self-contained system on board the aircraft that augments and/or integrates the information obtained from the other GNSS elements with information available on board the aircraft. ABAS meets ICAO’s GNSS signal-in-space performance requirements for accuracy, integrity, continuity and availability.

ABAS is the most cost-effective augmentation system, as it utilizes avionics already on board the aircraft.

IATA’s Position:

With the exception of GBAS for precision approach, ABAS is the preferred and most cost-effective system for augmenting the accuracy, integrity, availability, and continuity of the GNSS signal.

6.1.2 Ground Based Augmentation System (GBAS)

GBAS is an augmentation system in which the user receives augmentation information directly from a ground-based transmitter. GBAS uses a group of local ground stations, typically located at an airport, to collect information from the GPS constellation. The correction message is broadcasted from the local ground-based transmitter via a VHF data link to the aircraft operating within the range of the transmitter. A single GBAS installation, which should cost approximately the same as an ILS, is designed to provide precision approach capability for all runway ends at an airport.

GBAS meets ICAO's GNSS signal-in-space performance requirements for accuracy, integrity, continuity and availability. GBAS is intended to support all types of approach, landing, departure and surface operations and may support en-route and terminal operations. ICAO has published SARPs that support Category I precision approach with curved and segmented flight paths. The SARPs for Category II/III precision approach should be effective 2013.

GBAS has the potential to be a superior cost-effective replacement for ILS at a fraction of the cost of SBAS or ILS to all runway ends.

IATA’s Position:

IATA considers GBAS as the GNSS candidate to replace ILS CAT I/II/III. However, a business case is still required based on CAT II/III requirements.

6.1.3 Satellite Based Augmentation System (SBAS)

SBAS is a satellite based wide-coverage augmentation system in which the user receives augmentation information from a satellite-based transmitter. Compared to the other forms of augmentation, SBAS is extremely costly, as it comprises a network of ground-based reference stations to monitor satellite signals; master stations to process data from ground reference stations and generate SBAS signals; uplink stations to send messages to geostationary satellites, and satellite transponders to broadcast integrity and correction messages to aircraft. Additionally, SBAS would require costly changes to airborne equipage used by airlines today.

SBAS can provide vertical guidance down to 250-foot decision height, and the United States SBAS system (WAAS), under favourable specific conditions, can provide vertical guidance to a 200-foot decision height for Category I precision approach. In this case, there is a 50-foot improvement over RNP with Baro-VNAV. However SBAS is not a solution for 100-foot decision height or for auto-land. Moreover, the vast majority of airports that service air transport operators (and alternates) offer standard ILS operations. Therefore, SBAS is not an airline requirement but GBAS remains a requirement for the future implementation of GNSS Category II and III precision approach.

There are several SBAS systems either operational or under development that enhance the performance of the GPS signal for general public use, such as WAAS in North America, EGNOS in Europe, MSAS in Japan, and GAGAN in India. However, SBAS does not offer a global solution for aviation. There is no Cost-Benefit Analysis (CBA) supporting a business case for airlines, and their aircraft are not equipped for SBAS. Furthermore, most aircraft manufacturers do not offer SBAS avionics as an option for airlines, nor do they have plans to offer SBAS capability in the future - one reason being is that the new generation aircraft already have RNP 0.3-0.1 functionality already available. This capability combined with Baro-VNAV meets airlines' GNSS approach requirements until GBAS CAT II/III capability is available (around the 2013 timeframe).

In conclusion, airlines see no operational benefit from SBAS and are not convinced of its short or long term potential. Therefore, IATA does not support the continued development and implementation of SBAS.

IATA's Position:

Do not support the continued investment, development, and implementation of SBAS. No business case involving tangible operational benefits has been demonstrated for airlines in support of SBAS; therefore, this is the only GNSS augmentation system that airlines are not willing to pay for cost recovery.

7. Surveillance: Radar

Technologies used for surveillance of air transport category aircraft are varied. Systems currently employed include:

- Procedural Position Reports
- Primary Surveillance Radar (PSR)
- Secondary Surveillance Radar (SSR) – Mode A, Mode C, and Mode S
- Multilateration (MLAT)
- Precision Approach Radar (PAR)
- Automatic Dependent Surveillance – Contract (ADS-C)
- Automatic Dependent Surveillance – Broadcast (ADS-B)

ANSPs traditionally base aircraft surveillance on radar in dense airspace and voice or ADS-C position reports in remote and oceanic airspace. Where radar needs to be maintained or established, IATA views Secondary Surveillance Radar (SSR) & Mode S as the preferred technology. Further details on radar surveillance technologies are provided in the following sections.

7.1 Primary Surveillance Radar (PSR)

Primary surveillance radar (PSR) relies on a narrow beam of transmitted pulses of radio energy being reflected back from aircraft. The PSR uses the reflected energy to determine the aircraft's position for presentation on the controller's display.

Although in the past PSR provided useful support to en-route ATC, currently there is no airline requirement for using this technology. Secondary Surveillance Radar (SSR), Multilateration, and Automatic Dependent Surveillance Broadcast (ADS-B) have vastly superseded PSR.

Some ANSPs have justified PSR retention on its ability to detect thunderstorms. However, PSR has limited storm penetration and it may sometimes display rudimentary (or false) thunderstorm activity. Airborne radar systems provide accurate weather information to airlines and State meteorological services provide weather information derived from Doppler radar to ATC.

PSR remains the system of choice for the identification of unknown or unlawful intrusions into sovereign or territorial airspace. However, this is a national security service and its infrastructure cost should be borne by the State and not by air navigation fees for civil aviation.

Continued use of PSR within terminal areas may ensure detection and tracking of non-cooperative targets i.e. aircraft not equipped with SSR transponder or experiencing avionics failure. However, Multilateration (see section 8.6) will be a superior replacement for PSR in terminal airspace.

<u>IATA's Position</u>:

Do not support PSR deployment for civil air traffic services, as SSR and ADS-B have vastly superseded this technology and there is currently no operational benefit for PSR surveillance. Therefore, user charges associated with future upgrades or new PSR installations should be removed.

7.2 Secondary Surveillance Radar (SSR): Mode A/C and Mode S

SSR sends out signals that interrogate aircraft transponders. Replies provide position and include a four-digit identity code (Mode A) and pressure-altitude reports (Mode C). Replies are used to display aircraft position, altitude and identity on controllers' screens. Due to the increase in air traffic density, the number of potential Mode A code combinations became insufficient.

Mode S (Selective Addressing) is now a commonly employed SSR technique. Aircraft equipped with Mode S transponders are assigned a permanent and unique 24-bit ICAO address code. Mode S radars interrogate airframes selectively and receive individual replies. SSR Mode S improves the quality and integrity of the detection, identification and altitude reporting, overcoming some of the issues associated with mode A/C, such as the 4096-code limitation, radio frequency (RF) pollution, and lost targets.

<u>IATA's Position</u>:

Support SSR Mode S over SSR Mode A/C where radar must be established or replaced. SSR Mode S improves the quality and integrity of surveillance compared to Mode A/C.

7.3 Precision Approach Radar (PAR)

PAR allows controllers to monitor the approach path of an aircraft and provide lateral and vertical guidance by issuing instructions to pilots.

PAR is still used by military organisations but airline users no longer derive benefit from this technology.

<u>IATA's Position</u>:

- ***There is no airline requirement for PAR. User charges associated with existing PAR installations should be eliminated.***

8. Surveillance: Automatic Dependent Surveillance and Multilateration

In general, IATA views ADS-B IN based on the 1090 Extended Squitter (ES) data link as the most desirable next-generation form of surveillance, while acknowledging that equipage requirements are still being defined.

ADS-B and Multilateration (MLAT) build on a common technological framework. Surveillance based primarily on ADS-B and supplemented with MLAT should be used, whenever operationally feasible, as the next generation replacement to radar. In oceanic and remote areas, ADS-C is the preferred surveillance technology.

Technologies reviewed in this section include:
- Automatic Dependent Surveillance Broadcast (ADS-B) OUT
- Automatic Dependent Surveillance Broadcast (ADS-B) IN
- Candidate ADS-B Links
- Automatic Dependent Surveillance Contract (ADS-C)
- Traffic Information Service Broadcast (TIS-B)
- Multilateration (MLAT)

8.1 Automatic Dependent Surveillance Broadcast (ADS-B) OUT

ADS-B OUT is a surveillance technology by which an aircraft periodically and automatically broadcasts its state vector (horizontal and vertical position and velocity) and other aircraft data such as identification. Ground stations receive ADS-B OUT position reports and display them on air traffic controllers' screens. ADS-B OUT broadcasts may also be received, processed, and displayed by other aircraft in the vicinity that are equipped with ADS-B IN.

***IATA's Position*:**

Support implementation of ADS-B OUT based on Mode S Extended Squitter (1090ES) data link to supplement and eventually replace radar, and in non-radar airspace if traffic could benefit from ATC surveillance. Transition timelines need to be determined in consultation with airspace users. Operational and maintenance savings should be passed on to airspace users.

8.2 Automatic Dependent Surveillance Broadcast (ADS-B) IN

ADS-B IN is a surveillance technology by which an aircraft is able to broadcast as well as receive, process, and display the information broadcasted by another ADS-B equipped aircraft. Such information is shown on a Cockpit Display of Traffic Information (CDTI).

ADS-B IN is seen as a long-term (2020+) solution. Although information obtained through ADS-B IN greatly improves cockpit situational awareness and provides the potential for further shared air and ground separation responsibility, much remains to be accomplished in terms of system certification, application validation, human factors considerations / roles, procedures, and regulatory policies. Additionally, retrofit of existing fleets implies a major avionics upgrade and will require a lead-time of approximately ten years.

IATA's Position:

ADS-B IN is seen as the preferred next generation surveillance technology for air transportation. IATA endorses the concept of ADS-B IN according to ICAO's Global Air Navigation Plan.

However, before going forward with implementation, global consensus must be reached on:

- ***Avionics requirements and standards***
- ***Roles, responsibilities, and liabilities of pilots and air traffic controllers***
- ***Cost and benefit Analysis that presents a positive business case for airspace users and ATS providers.***

8.3 Candidate ADS-B Data links

ICAO has formalized standards for three broadcast mode data links for ADS-B: 1090 MHz Mode S Extended Squitter (1090 ES), VDL Mode 4, and Universal Access Transceiver (UAT).

Although there are three standards, there is general global consensus, including IATA, CANSO, EUROCONTROL, FAA, Airbus and Boeing, to use 1090 ES as the supporting data link for international ADS-B applications, as it is available and mature, enabling early implementation.

The majority of stakeholders do not support VDL Mode 4 after consideration of the risks and investments associated to its implementation versus the added value.

UAT carriage is of no interest to commercial air carriers.

IATA's Position:

Support Mode S 1090 ES as the single, interoperable data link to support ADS-B for the foreseeable future. Mode S 1090 ES is a technology available and mature today, enabling early application. IATA does not support VDL Mode 4 or UAT for international air traffic services or user charges associated with these technologies.

8.4 Automatic Dependent Surveillance Contract (ADS-C)

ADS-C is a surveillance technology designed for oceanic and remote airspace. ADS-C reports are sent from the aircraft to ATC via a VHF or SatCom data link and include position, velocity, intent, and weather.

Reports are automatically generated based on an electronic contract established between the aircraft Flight Management System (FMS) and a ground-based ATC installation. An aircraft typically transmits its information every 32, 27, or 14 minutes (per ICAO PANS-ATM recommendation for 50nm or 30nm separation minima), as determined by the FMS electronic contract with ATC. Contracts could be based on a specified reporting rate, event, or on-demand. The information is displayed to ATC and can also be used by automated flight tracking and monitoring systems.

IATA's Position:

Support ADS-C based surveillance for oceanic and remote airspace where appropriate. ADS-C contracts should be determined with an agreed service in consultation with airspace users, i.e. a 32 minute periodic contract for a RNP4 approved aircraft for 50NM longitudinal separation or a 14 minute periodic contract for a RNP4 approved aircraft for 30NM longitudinal separation, etc.

8.5 Traffic Information Service - Broadcast (TIS-B)

TIS-B enables SSR (Mode S and Mode A/C) or ADS-B surveillance data from multiple link sources to be combined and uplinked to an aircraft equipped with ADS-B IN, increasing situational awareness in the cockpit.

TIS-B is designed to deliver benefits in a mixed surveillance environment during the transition from radar to ADS-B surveillance or in a dual link ADS-B environment. TIS-B could fulfill an intermediary role until full deployment of ADS-B IN. It is anticipated that cockpit display of traffic information (CDTI) will predominantly be based on TIS-B during the initial transition period from radar to ADS-B IN.

IATA's Position:

Support a single data link standard based on 1090ES. If a single standard is not implemented, then ADS-B IN systems will require TIS-B functionality to display all aircraft of relevance in any given traffic situation. TIS-B should be considered to increase situational awareness during the transition from radar to a full ADS-B environment.

8.6 Multilateration (MLAT)

MLAT is a ground based surveillance system that uses transmissions from a transponder, Traffic Collision Avoidance System (TCAS), ADS-B, or military IFF transmissions to triangulate the position of a cooperative target. MLAT is also known as Hyperbolic Positioning and functions by measuring the Time Difference of Arrival (TDOA) of a signal at a number of dispersed receivers.

Note: Wide Area Multilateration (WAM) is a term commonly used to describe the surveillance of en-route airspace, while the abbreviation MLAT tends to be employed when discussing the monitoring of terminal airspace and airport surface traffic.

A limited number of ANSPs have deployed MLAT/WAM for ATM surveillance in combination with ADS-B or SSR to meet specific surveillance requirements. Some ANSPs are also deploying

MLAT as a Precision Runway Monitor (PRM) sensor and for surveillance of airport ground movements. Additional MLAT/WAM applications include ADS-B backup and RVSM height monitoring.

Depending upon the required number of sites and their locations, MLAT/WAM systems can cost considerably less than conventional radar to purchase, install, and maintain.

Global MLAT separation standards have been agreed. The Aeronautical Surveillance Panel (ASP) and the Separation and Airspace Safety Panel (SASP) have developed ICAO guidance materials and separation minimums of 5nm and 3nm for MLAT/WAM. Anticipated availability is 2010.

IATA's Position:

Support MLAT to meet specific surveillance requirements when supported by clear operational requirements, separation minima, and a Cost-Benefit Analysis (CBA) involving all stakeholders. If MLAT is deployed, it should be configured to facilitate possible integration of ADS-B ground stations in a future surveillance mix.

9. OTHER DATA LINK OPERATIONAL SERVICES

Airlines support the move to migrate to a fully digital environment for aeronautical information and meteorological services to ensure that information is made available to the user in a timely manner.

This section provides an overview on the following technologies and applications:

- Digital Automatic Terminal Information Service (D-ATIS)
- Automated Weather Observing System (AWOS)
- Departure Clearance Service (DC)

9.1 Digital Automatic Terminal Information Service (D-ATIS)

ATIS is predominantly a voice broadcast service over a dedicated VHF frequency that provides operational information to aircraft operating in the vicinity of an airport, eliminating the need for a controller to transmit the information to each aircraft individually. It is normally accomplished through a voice recording, updated when conditions change.

Data link is an alternative means of transmitting ATIS to suitably equipped aircraft. It reduces flight crew workload as D-ATIS information is printed on a cockpit printer or is recallable on a data link display.

IATA's Position:

Support D-ATIS deployment at major international airports while providing dual-stack support during transition from ATIS to D-ATIS.

9.2 Automated Weather Observing System (AWOS)

AWOS is a suite of sensors that measure, collect, and disseminate weather data to help meteorologists, pilots, and flight dispatchers prepare and monitor weather forecasts. The sensors measure such elements as wind velocity, ambient air and dew point temperatures, visibility, cloud height and sky condition, precipitation occurrence and type, as well as identifying icing or freezing conditions.

In addition to safety benefits associated with weather, AWOS facilitates potential reduction in flight disruptions.

IATA's Position:

Support AWOS where operationally justified and cost-effective, for example, at airports where weather observers are not available 24 hours.

9.3 Pre-Departure Clearance Service (PDC)

A flight due to depart from an airfield must first obtain departure information and clearance from the controlling ATS unit. The pre-departure clearance service provides an automated means for requesting and delivering clearances, with the objective of reducing pilot and controller workload and diminishing clearance delivery delays.

The benefits for the introduction of PDC are:

a) Reduction of the potential for communication errors between pilots and controllers;
b) Reduction of frequency congestion;
c) Reduction of ground delays.

IATA's Position:

Support PDC deployment at major international airports to supplement and eventually replace conventional voice clearances.

10. SPECTRUM REQUIREMENTS FOR INTERNATIONAL CIVIL AVIATION

Performance of CNS/ATM systems are dependent upon the availability of radio frequency spectrum that can support the integrity and availability requirements associated with aeronautical safety of life systems, and demands special protection measures to avoid harmful interference to these systems. It was recognized by the ICAO 11th Air Navigation Conference that new radio spectrum for CNS/ATM systems will be required while the current systems continue to be maintained.

Global allocations of radio spectrum, including that for aviation, are agreed by the 191 States of the International Telecommunications Union (ITU) at World Radiocommunication Conferences (WRCs), which meet every 3-4 years. The resolutions that come out of these meetings become radio regulations and, once signed by States, have the status of international treaties.

Article 4.10 of the Radio Regulations states that ITU Member States recognize that the safety aspects of radionavigation and other safety services requires special measures to ensure their freedom from harmful interference. These factors must be taken into consideration in the allocation, assignment and use of frequencies for aeronautical systems.

IATA's Position:

To work jointly with ICAO to promote a common aviation position at the ITU WRC that aims to preserve and protect aeronautical spectrum for radiocommunication and radionavigation systems, which are required for current and future safety-of-flight applications.

11. CONCLUSION

The introduction of any new technology must be managed in a manner that enables airlines to develop a business case with near-term investment payback. IATA encourages ANSPs / States to only adopt technologies which have valid business and operational cases as agreed in consultation with airlines and other airspace users.

There are many technological “solutions” that have been developed by industry for air traffic services. However, unless they are adopted as a global standard and have agreed cost/benefits and implementation timelines with the airspace users, such technologies have no value to international aviation. For technologies that will soon be introduced (e.g., ADS-B, Multilateration, GBAS, etc.), it is essential that each application undergoes a thorough due process of safety case analysis, agreed cost-benefit, development of globally harmonized policies and procedures, establishment of separation minimums and standards, and setting of deployment timelines, involving all airspace users.

IATA is happy to address specific questions on infrastructure. Please send questions and comments to…

infrastructure@iata.org

GLOSSARY

ABAS	Aircraft Based Augmentation System
ACARS	Aircraft Communications Addressing and Reporting System
ACAS	Airborne Collision Avoidance System
ADS	Automatic Dependent Surveillance
ADS-B	Automatic Dependent Surveillance – Broadcast
ADS-C	Automatic Dependent Surveillance – Contract
AIDC	Air Traffic Services Interfacility Data Communication
AMSS	Aeronautical Mobile Satellite Service
ANS	Air Navigation Services
ANSP	Air Navigation Service Provider
AOC	Aeronautical Operational Control Communications
APV	Approach with Vertical Guidance
ASP	Aeronautical Surveillance Panel
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
ATM	Air Traffic Management
ATN	Aeronautical Telecommunications Network
ATS	Air Traffic Services
AWOS	Automated Weather Observing System
Baro-VNAV	Barometric Vertical Navigation
CANSO	Civil Air Navigation Services Organization
CBA	Cost-Benefit Analysis

CDTI	Cockpit Display of Traffic Information
CNS/ATM	Communications Navigation Surveillance/Air Traffic Management
COTS	Commercial Off-The-Shelf
CPDLC	Controller Pilot Data Link Communications
CSMA	Carrier Sense Multiple Access
D-ATIS	Digital - Automated Terminal Information Service
DL	Data Link
DME	Distance Measuring Equipment
EGNOS	European Geostationary Navigation Overlay Service (Europe)
ES	Extended Squitter
EURO-CONTROL	European Organisation for the Safety of Air Navigation
FAA	Federal Aviation Administration (USA)
FANS	Future Air Navigation Systems (FANS)
FIR	Flight Information Region
FMS	Flight Management System
GAGAN	GPS Aided Geo Augmented Navigation (India)
GBAS	Ground Based Augmentation Service
GEO	Geosynchronous Orbit
GES	Ground Earth Station
GLS	GNSS Landing System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HF	High Frequency

HFDL	High Frequency Data Link
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IEEE	Institute of Electrical and Electronics Engineers
IFF	Identification Friend or Foe
ILS	Instrument Landing System
IRNSS	Indian Regional Navigational Satellite System
ISO	International Organization for Standardization
IP	Internet Protocol
IT	Information Technology
ITU	International Telecommunications Union (ITU)
LEO	Low- Earth Orbit
MLS	Microwave Landing System
MSAS	MTSAT Satellite Based Augmentation System (Japan)
MTSAT	Multi-functional Transport Satellites (Japan)
NextGen	Next Generation Air Transportation System
NDB	Non Directional Beacon
NRA	Non-Radar Airspace
OSI	Open Systems Interconnection
PAR	Precision Approach Radar
PBN	Performance Based Navigation
PDC	Pre-Departure Clearance
PRM	Precision Runway Monitor

RAIM	Receiver Autonomous Integrity Monitoring
RF	Radio Frequency
RNAV	Area Navigation
RNP	Required Navigation Performance
RNP APCH	Required Navigation Performance Approach
RNP/AR	Required Navigation Performance Authorization Required
RVSM	Reduced Vertical Separation Minimum
SASP	Separation and Airspace Safety Panel
SARPs	Standards and Recommended Practices
SBAS	Satellite Based Augmentation System
SESAR	Single European Sky ATM Research
SMR	Surface Movement Radar
SSR	Secondary Surveillance Radar
STDMA	Self-Organising Time Division Multiple Access
SWIM	System Wide Information Management
TCAS	Traffic Collision Avoidance System
TDMA	Time Division Multiple Access
TDOA	Time Difference of Arrival
TIS-B	Traffic Information Service Broadcast
TMA	Terminal Area
UAT	Universal Access Transceiver
VDL	VHF Digital Link
VHF	Very High Frequency

VNAV	Vertical Navigation
VoIP	Voice over IP
VOR	VHF Omni-directional Range
WAM	Wide Area Multilateration
WAAS	Wide Area Augmentation System (USA)
WGS-84	World Geodetic System –1984
WIMAX	Worldwide Interoperability for Microwave Access

APPENDIX 1.

User Requirements for Air Traffic Services – Planning Checklist

Some of the questions that ANSPs, States and international funding organizations need to answer when planning for the implementation of new technology are:

- What are the current and forecast requirements of airlines?
- What are the benefits of this technology to airlines in terms of safety, schedule maintenance, operation and efficiency?
- What is the timeline for realization of benefits and technology transition?
- What are the system and infrastructure requirements as well as the policies and procedures necessary to enable full realization of technology benefits?
- What is the cost to airlines in terms of increased air navigation and communication fees, on-board equipment, aircraft down time, training, maintenance, etc?
- When do these benefits recover the associated costs?
- Does the technology meet existing international standards? If new standards are required, will they be ready within an appropriate timeframe?
- Is the investment consistent with international planning, and does it contribute to seamlessness of regional and global airline operations?
- Does the technology represent the most effective use of resources?
- Is the purchase consistent with an incremental approach to technology deployment that promises early benefits to airlines and a path to future benefits?
- Are neighbouring ANSPs and States willing to consider sharing common infrastructure projects in order to save costs and promote seamless operations?

Agenda Item 3: Implementation of performance-based navigation (PBN) in the SAM Region

En-Route PBN Action Plan (RNAV-5)

3.1 In view that the En-route PBN Action Plan (RNAV-5) contemplates tasks assigned to responsible officers defined, with established dates of compliance, a periodical revision is necessary, as a follow-up of the status of compliance of the tasks assigned to each one of the persons responsible designated by the Implementation Group. To this end, **Appendix A** to this part of the report shows the tasks that must be complied at the time RNAV 5 is implemented foreseen for 18 November 2010.

3.2 When analysing item 2 of the RNAV-5 Plan, the Meeting was of the opinion that this task should be moved to the SAM Routes Network Optimisation Programme, keeping in mind that the necessary performance measures to implement version 1 of the SAM routes network, shall be established in the mentioned programme.

PBN En-route action plan (RNAV5) OPS/AIR Area

3.3 The Meeting, based on the background provided by the Secretariat and the OPS/AIR Group members, could appreciate the following status of progress in the tasks inherent to this working group:

Task 1.3 The information of some States is missing

Task 5.2 There are some States in development process of their regulations, and for this reason, this task is pending.

Task 5.3 This is a continuous task that States have initiated and shall continue to carry out upon requirement of operators

Task 5.4 This is an activity being developed permanently by each on of the States

Task 5.5 This is an activity being developed permanently by each on of the States and is considered in the surveillance plans

Task 7.1 The matters to be incorporated into each one of the training programmes of operators have been included in the corresponding advisory circulars.

Task 7.3 The SRVSOP technical committee has proposed a training programme oriented to the authorities (See WP/33)

Task 7.5 There is information that only some States have initiated the process of orientation to operators, for this reason all States are encouraged to implement a dissemination programme among such operators, taking into consideration plans of the State, its operational, economic, environmental benefits, together with the corresponding regulations to be used.

3.4 The SAM/PBN/IG has developed the PBN implementation programme for en-route operations, which establishes the deliverables, with the necessary dates for RNAV 5 implementation in November 2010, approved by Conclusion SAM/IG/2-1. Taking into consideration the need for a Regional harmonization of PBN implementation for en-route operations, the coordination and execution of the RNAV5 implementation tasks are being developed by the SAM/PBN/IG, with the support of Regional Project RLA/06/901. The action plan models for PBN implementation in TMA and Approach, taking into consideration SAM States requirements, were also prepared by the SAM/PBN/IG.

3.5 With a view to enable a harmonization of the SAM States national plans, before their submission to the ICAO Regional Office, the SAM/IG/3 Meeting formulated Conclusion SAM/IG/3-3, requesting the presentation of national PBN implementation plans at the SAM/IG/4 Meeting.

National Action Plans for PBN implementation

3.6 The Meeting recalled that Resolution A36-23 requires that the Planning and Implementation Regional Groups (PIRG) and States develop their national PBN implementation Plans for 2009, with a view to:

a) Implement RNAV and RNP operations (where required) for en-route operations (oceanic and continental) and terminal control areas (TMA), as per established deadlines and to intermediary frameworks; and

b) Implement approach procedures with vertical guidance (APV) Baro-VNAV or SBAS-based, for all runway ends operating IFR, either as primary approach or backup for precision approaches until 2016, with the following intermediary frameworks: 30% until 2010 and 70% until 2014.

3.7 At a Regional level the GREPECAS PBN Task Force has developed action plans for PBN, en-route, TMA and approach implementation, which could be used by States in the preparation of their national PBN implementation plans. Also, keeping in mind the need for harmonization of the CAR/SAM Regions national plans, as well as the requirement to develop a PBN implementation Regional plan, GREPECAS/15 has formulated Conclusion 15/38, encouraging CAR/SAM States/Territories to develop their national PBN implementation plans for December 2009, and present them to the corresponding Regional Offices.

3.8 Also, within the environment of the CAR/SAM Regions, the ATM Authorities and Planners Meetings (APATM) developed a CAR/SAM PBN Roadmap, which contains the general guidelines for PBN implementation in the CAR/SAM Regions, in all flight phases. The mentioned roadmap was approved by GREPECAS Conclusion 14/46 and was amended by GREPECAS/15, in order to include APV Baro-VNAV based approaches. Approval of this modification is included in paragraph 3.6.23 of the GREPECAS/15 final report.

3.9 The Meeting evaluated the national plans presented by Argentina, Bolivia, Brazil, Chile, Colombia, Paraguay, Peru and Uruguay. It could be noted that, in spite differences exist among national PBN plans, the same contain required basic information. However, the Meeting was of the opinion that, in order to ensure above-mentioned harmonization, the minimum content of PBN plans of SAM States should be as follows:

a) En-route operations – action plan for RNAV-5 implementation.

b) TMA operations – State planning for PBN SID/STAR Implementation in the main TMAs

c) Approaches – planning to ensure the compliance of goals established in Resolution A 36/23 for APV procedures.

3.10 The Secretariat, in consultation with ICAO Headquarters, has informed the Meeting that percentages related to the implementation of APV procedures are applied in all thresholds operating IFR, independently if they are located in national or international airports.

3.11 Argentina informed that their objective for APV Baro-VNAV implementation is 30% of all international airports.

3.12 Keeping in mind the need to compliance with APV procedures implementation, established in Resolution A36-23, as well as attending PBN implementation in TMA, the Meeting recognised that States should ensure, as far as possible, exclusive dedication to their procedures designers to the PBN implementation project.

3.13 The Meeting recalled that SAM States should present to the SAM Regional Office their definitive national PBN plans by December 2009.

AIC assessment containing the proposal for PBN implementation planning in Brasilia, Recife, Rio de Janeiro and Sao Paulo TMA

3.14 The Meeting took note that the Regional Project RLA/06/901 developed a PBN implementation plan in TMA and Approach, in order to enable a better understanding of the activities and results expected. The objective was to clearly define the products to be delivered, in order to break down the great workload in specific activities. These activities will be used as a foundation for the drafting of the programmes schedule.

3.15 The Meeting also noted that the Brazilian administration had adopted the action plan aforementioned, and that one of the essential activities of such plan is the publication of an AIC reporting PBN implementation planning, keeping in mind the need that aircraft operators carry out necessary activities for airworthiness and operations approval.

3.16 The AIC of the Brazilian administration, in addition to the reporting of PBN implementation, has the aim to initiate the development of application procedures of the different navigation specifications, in airspace with ATS surveillance. This AIC generated a thorough technical discussion on different aspects included in the mentioned proposal.

3.17 The initial planning of Brazil foresees, in case of Brasilia, Recife, Rio de Janeiro and Sao Paulo TMAs that SID/STARs could be executed with the following navigation specifications: RNAV-2, RNAV-1 and basic RNP-1. Approaches could be used with RNP APCH specifications with or without BARO-VNAV application.

3.18 The Meeting noted it had the new SID and STAR and approach procedures in TMAs involved could, initially be involved as well, until the fleet is RNAV-1 approved, or Basic RNP-1, be used by aircraft and operators that have approval for the use of GNSS for departure, arrival and approach.

3.19 In addition, the Meeting noted that the Brazilian administration is evaluating the possibility of the RNAV-5 use in SID and STAR, keeping in mind that some TMAs will not have an adequate DME coverage to serve RNAV-2 and RNAV-1 specifications. In this case, RNAV-5 application shall be carried out under the following conditions:

a) RNAV STAR – The aircraft shall be cleared to descend up to the minimum flight level in the FIR (FL 110 in the Curitiba and Brasilia FIRs, FL 080 in the Amazónica and Recife FIRs). In entering the sector minimum altitude area (MSA), the aircraft may be able to continue descending up to MSA. The descent below MSA will only be cleared with the use of radar vectors.

b) SID RNAV – The aircraft will initially execute a "conventional" exit. In crossing the flight minimum altitude in the corresponding FIR, the aircraft will be able to be cleared to intercept an RNAV SID.

3.20 The Meeting was of the opinion that RNAV-5 application in SID and STAR could be a problem for harmonization of operations in the SAM Region, keeping in mind that such navigation specification was developed for en-route operations, due to limited functionalities required in the navigation system.

3.21 Keeping in mind that a significant portion of STARs developed by Brazil could be considered as feeder routes, the Meeting suggested that this solution be considered, with a view to ensure PBN harmonization in the Region.

3.22 Another aspect mentioned during the discussions was the issue of identification of SID and STAR, as per Doc. 8168 and Annex 4. In this connection, the Meeting observed that the Brazilian AIC considers the navigation sensor in the title of the chart, while the mentioned ICAO documentation indicates that this information must be inserted as a note in the chart.

3.23 The Meeting observed in the AIC, that the Brazilian Administration has planned in advance some parts of amendment 1 to Doc. 4444, which effective date is November 2012, with a view to provide the air traffic controller the knowledge of the status of approval of aircraft and operators for different navigation specifications. In this connection, the Meeting was informed that Brazil has already hired the necessary changes in the ATC automated systems, with a view to present in the flight progression band and in the radar label the essential information for ATC planning. Thus, it will be necessary that aircraft operators shall also insert the corresponding codes in boxes 10 and 18 of the FPL. In addition, aircraft operators shall also have to insert the mentioned information in the RPL. Keeping in mind that amendment 1 to Doc. 4444 does not cover an amendment in RPL for, the Brazilian Administration has decided to adopt, preliminarily, the same codes used in RVSM implementation.

Benefits obtained after RNP AR implementation in La Florida aerodrome, La Serena City

3.24 The Chilean administration presented information on the results of RNP AR implementation at La Florida aerodrome, in La Serena City. In June 2009, the airline LAN finalized the process of certification and aircraft and crew clearances currently operating in La Serena aerodrome, to initiate, as of that date the use of the RNP AR procedure in all its regular flights with this destination.

3.25 The following chart compares the months of June, July and August 2008 with the same period on 2009:

	Jun/Jul/Aug 2008	**Jun/Jul/Aug 2009**
Unsuccessful Approaches due to MET condition	10	1
Flights which returned to SCEL without being able to land	5	0
Landing rate of unstabilized	11,6%	0%
Minutes of delay accumulated within the period	1647	790
Cancelled flights	10	2

3.26 Making an estimation, based on the average consumption of an A-318, it may be stated that the 5 flights which returned to Santiago (1 hour of each flight approximately) added to the 10 frustrated approaches, (26 NM each approach) corresponding to the period considered in 2008, generated in the environment a figure near 53 tons of CO_2.

3.27 In addition to the above, for each approach, a minute of flight is saved, which is equal to an average of 50 kg of fuel not consumed and 160 Kg. of CO_2 not emitted to the **atmosphere** per flight carried out. In these three months of utilisation of the procedure, around 300 flights have been carried out to La Serena from Santiago, which is translated into 48 tons of CO2 not emitted to the atmosphere.

APPENDIX A

SHORT-TERM EN-ROUTE PBN ACTION PLAN (RNAV-5)
(GPIs 1, 4, 5, 7, 8, 10, 11, 12, 16, 21, 23)

1.	**Airspace concept**	**Start**	**End**	**Responsible party**	**Remarks**
1.1	Establish and prioritize strategic objectives (safety, capacity, environment, etc.)	June/2008	SAM/IG/2	SAM/PBN/IG (Project RLA/06/901)	Completed
1.2	Collect traffic data in order to understand traffic flows in a given airspace	June/2008	SAM/IG/4	SAM/PBN/IG (Project RLA/06/901)	Completed
1.3	Analyze the navigation capacity of the aircraft fleet	June/2008	SAM/IG/4	SAM/PBN/IG (Projects RLA/06/901 and RLA/99/901) States IATA	Valid During SAM/IG/4 Meeting, the database was analysed. Will continue to improve with the assistance of States.
1.4	Analyze ground-based means of communication, navigation (VOR, DME) and surveillance to meet navigation specifications and the navigation reversal mode	June/2008	SAM/IG/5	SAM/PBN/IG (Projects RLA/06/901 and RLA/99/901) States	In process. During SAM/IG/4 initial information was presented (WP/35). The final result will be presented to SAM/IG/5.
1.5	Optimize airspace structure, reorganizing the network or implementing new routes based on the strategic objectives of the airspace concept, taking into account airspace modelling, ATC simulations (fast time and/or real time), live tests, etc.	SAM/IG/2	SAM/IG/4	SAM/PBN/IG (Project RLA/06/901) States IATA	In process.
					The meeting examined this task and decided that it was more appropriate to incorporate to the action plan of the optimisation programme of the SAM Region ATS routes network
					No activity has been initiated yet. Id above.

2	Safety assessment	Start	End	Responsible party	Remarks
2.1	Prepare safety assessment execution using a qualitative methodology through the application of SMS	SAM/IG/2	SAM/IG/5	CARSAMMA Project RLA/06/901 Regional Office	RLA/06/901 in order to provide guidance material to CARSAMMA The utilisation of qualitative methodology initially defined through the application of SMS processes

3	Establish a collaborative decision-making process (CDM)	Start	End	Responsible party	Remarks
3.1	Coordinate planning and implementation requirements with air navigation service providers, regulators, users, aircraft operators and military authorities	SAM/IG/2	SAM/IG/4	SAM/PBN/IG States	States have published an initial AIC
3.2	Establish the implementation date	SAM/IG/1	SAM/IG/4	SAM/PBN/IG States	**Completed.** 18 November 2009 was established as tentative date. States must analyse the feasibility of the tentative date in coordination with domestic operators and military authorities
3.3	Establish the documentation format in the SAM PBN website	SAM/IG/1	SAM/IG/2	SAM Regional Office	**Completed**
3.4	Report planning and implementation progress to the corresponding Regional Office. Conclusion to present national plans at SAM/IG/4	SAM/IG/2	SAM/IG/4	SAM/PBN/IG States	**Completed.** Eight SAM States presented a draft of their national PBN implementation plans and it was agreed that for 31 December 2009, States shall present the final version of the plan. The Secretariat was requested to as States that have not done so yet, submit their respective plans.

4	**ATC automated systems**	**Start**	**End**	**Responsible party**	**Remarks**
4.1 Note:	Assess PBN implementation in ATC automated systems, taking into account amendment 1 to the PANS/ATM (FPLSG). It is not a requirement for RNAV5 implementation	June/2008	SAM/IG/4	SAM/PBN/IG (Project RLA/06/901)	**Completed** According to the programme presented in ICAO guidelines (WP/09), it is not a requirement for the RNAV5 implementation. CNS/ATM sub-group will revise this issue.
4.2	Implement necessary changes in automated ATC systems	SAM/IG/2	TBD	States	**Completed**

5	Aircraft and operator approval	Start	End	Responsible party	Remarks
5.1	Analyze aircraft and operator approval requirements (pilots, dispatchers and maintenance personnel) in keeping with the PBN manual, and develop the necessary documentation.	June/2008	SAM/IG/2	Regional Project RLA/99/901- Regional Safety Oversight Cooperation System	**Completed**
5.2	Publish national regulations for the implementation of the RNAV-5 navigation specification	SAM/IG/2	SAM/IG/4	States	**Valid** There are some States in development process of their regulations, and for this reason, this task is pending.
5.3	Begin the approval of aircraft and operators	SAM/IG/3	SAM/IG/5	States	**Valid** This is a continuous task that States have initiated and shall continue to carry out upon requirement of operators
5.4	Establish and keep up to date a registry of approved aircraft and operators	SAM/IG/3	Permanent	CARSAMMA States Regional Office	**Valid** This is an activity being developed permanently by each on of the States.
5.5	Verify the operation of the continuous monitoring programme (aircraft and procedures)	Nov/2010	Permanent	States	**Completed** This is an activity being developed permanently by each on of the States and is considered in the surveillance plans.

6	Standards and procedures	Start	End	Responsible party	Remarks
6.1	Assess and, if applicable, publish the regulations on the use of GNSS.	June/2008	SAM/IG/2	SAM/PBN/IG (Project RLA/06/901) States	**Completed**
6.2	Finalize WGS-84 implementation	TBD	TBD	States	**Completed** States which have not done so, should provide the information
6.3	Develop an AIC model to report PBN implementation plans	June/2008	SAM/IG/2	SAM/PBN/IG (Project RLA/06/901)	**Completed**
6.4	Publish the AIC reporting PBN implementation plans	SAM/IG/2	SAM/IG/4	States	**Completed** States should publish on 9 April 2009
6.5	Develop an AIP Supplement model containing applicable standards and procedures, including the corresponding in-flight contingencies	SAM/IG/4	SAM/IG/5	SAM/PBN/IG (Project RLA/06/901)	RLA/06/901 should carry out this task
6.6	Publish the AIP Supplement containing applicable standards and procedures, including the corresponding in-flight contingencies	SAM/IG/5	SAM/IG/6	States	
6.7	Review the Procedural Handbook of the ATS units involved	SAM/IG/5	SAM/IG/6	States	
6.8	Update the letters of agreement between ATS units	SAM/IG/5	SAM/IG/6	States	
6.9	Develop an amendment to regional documentation, if necessary	SAM/IG/3	SAM/IG/4	SAM/PBN/IG (Project RLA/06/901)	RLA/06/901 should carry out this task
6.10	Submit a proposal of amendment to Doc. 7030, if necessary	SAM/IG/5	SAM/IG/6	SAM Regional Office	
					The meeting considered that this task is associated to task 2.1 and should be included in the action plan of the

6 Standards and procedures	Start	End	Responsible party	Remarks
				optimisation programme of the SAM Region ATS routes network

7.	Training	Start	End	Responsible party	Remarks
7.1	Develop a training and documentation programme for operators (pilots, dispatchers and maintenance personnel)	SAM/IG/4	SAM/IG/5	Regional Project RLA/99/901	**Completed** The matters to be incorporated into each one of the training programmes of operators have been included in the corresponding advisory circulars
7.2	Develop a training and documentation programme for air traffic controllers and AIS operators	SAM/IG/4	SAM/IG/5	SAM/PBN/IG (Project RLA/06/901)	RLA/06/901 should execute this task.
7.3	Develop a training programme for regulators (aviation safety inspectors)	SAM/IG/4	SAM/IG/5	RLA/99/901 States	**Completed** The SRVSOP technical committee has proposed a training programme oriented to the authorities
7.4	Conduct training programmes	SAM/IG/5	SAM/IG/6	States	**Valid** Only some States have initiated this process.
7.5	Conduct seminars for operators, explaining plans and expected operational and economic benefits	SAM/IG/1	SAM/IG/6	States	**Valid** There is information that only some States have initiated the process

8.	**Implementation decision**	**Start**	**End**	**Responsible party**	**Remarks**
8.1	Assess the available operational documentation (ATS, OPS/AIR)	SAM/IG/5	N/A	States	
8.2	Assess the percentage of aircraft and operators (non-exclusionary airspace)	SAM/IG/5	N/A	States	
8.3	Analyze the results of the safety assessment	SAM/IG/5	N/A	States	
8.4	Publish trigger NOTAM	Nov/2010	N/A	States	

9. Performance monitoring system	**Start**	**End**	**Responsible party**	**Remarks**
9.1 Develop a post-implementation en-route operations monitoring programme	SAM/IG/4	SAM/IG/5	SAM/PBN/IG (Project RLA/06/901)	
9.2 Implement a post-implementation en-route operations monitoring programme	Nov/2010	Nov/2011	States	
Pre-operational implementation date	18 November 2010	N/A		SAM/IG/4 defined the tentative implementation date 18 November 2010.
Definitive implementation date	Nov/2011	N/A		

Agenda Item 4: Standards and procedures for performance-based navigation operations approval

Progress of work made in the framework of Project RLA/99/901 related to the performance based navigation

4.1 With regard to the progress of work in the field of Project RLA/99/901 on the performance-based navigation, the Meeting took note on the development of the following Advisory Circulars (AC):

- ✓ AC 91-001 – Aircraft and operators approval for RNAV 10 operations (designated and authorized as RNP 10);
- ✓ AC 91-003 - Aircraft and operators approval for RNAV 1 and RNAV 2 operations; and
- ✓ AC 91-006 – Aircraft and operators approval for basic RNP 1 operations.

4.2 *The AC 91-001 - Aircraft and operators approval for RNAV 10 operations (designated and approved as RNP 10*), establishes the RNP 10 approval criteria for aircraft and operations in oceanic or remote airspace. This AC is entitled RNAV 10 in order to be consistent with the criteria set forth in ICAO Doc 9613 – *Performance-based navigation (PBN) manual*. This new designation and version of this document does not change any requirement nor does it affect operators that have already obtained an RNP 10 approval by the Civil Aviation Authority (CAA). RNP 10 operations in oceanic or remote areas with no ground-based navigation aids, except for isolated areas, require aircraft navigation to be based on long-range navigation capability with inertial navigation and/or global positioning systems.

4.3 *The AC 91-003 - Aircraft and operators approval for RNAV 1 and RNAV 2 operations*, provides the RNAV 1 and RNAV 2 approval criteria for aircraft and operations en-route and in terminal area. The guidance material of this AC harmonizes the European and the United States RNAV criteria within a single navigation specification designated as RNAV 1 and RNAV 2 in accordance with ICAO Doc 9613. The navigation specification RNAV 1 and RNAV 2 applies to all ATS routes, including those established in the en-route domain; to standard instrument departures and arrivals (SID / STAR) and to instrument approach procedures up to the final approach fix (FAF)/final approach point (FAP). The criteria for final approach from the FAF to the runway threshold, together with the associated missed approach maneuver, are not considered in this document and will be object of another AC.

4.4 The *AC 91-006 - Aircraft and operators for basic RNP 1 operations*, provides the basic RNP 1 approval criteria for aircraft and operations in terminal area. This navigation specification is used in standard instrument departures and arrivals (SID / STAR) and in approaches up to the final approach fix (FAF) /final approach point (FAP) with no or limited ATS surveillance. With the use of this navigation specification, it is planned to perform similar operations to RNAV 1 and RNAV 2, but outside radar coverage.

4.5 The implementation in the SAM Region of RNAV 10 (designated and authorized as RNP 10), RNAV 1 and RNAV 2 and Basic-RNP 1, requires the participation of all States and the need to harmonize the requirements and procedures of this type of operations.

4.6 Before authorizing the RNAV 10 (designated and authorized as RNP 10), RNAV 1 and RNAV 2 and Basic-RNP 1, the States should include in their national regulations the requirements for these navigation specifications and develop procedures related to the aircrafts and operators approval.

4.7 Taking into account that ACs for RNAV 5, RNP APCH, RNP AR APCH and APV/baro-VNAV were reviewed by the TC of SRVSOP to incorporate the changes agreed at the SAM/IG/2 and SAM/IG/3 Meetings, respectively, these documents were presented again along with the foreseen ACs related to RNAV 10 (designated and authorized as RNP 10), RNAV 1 and RNAV 2 and basic RNP1 for this Meeting.

4.8 In total, the following 7 CAs were presented with their respective job aids in the appendices which are detailed below:

- ✓ Appendix A-1: AC 91-001 – Aircraft and operators approval for RNAV 10 operations (designated and authorized as RNP 10)
- ✓ Appendix A-2: RNAV 10 Job Aid

- ✓ Appendix B-1: AC 91-002 - Aircraft and operators approval for RNAV 5 operations
- ✓ Appendix B-2: RNAV 5 Job Aid

- ✓ Appendix C-1: AC 91-003 - Aircraft and operators approval for RNAV 1 and RNAV 2 operations
- ✓ Appendix C-2: RNAV 1 and RNAV 2 Job Aid

- ✓ Appendix D-1: AC 91-006 – Aircraft and operators approval for Basic-RNP 1 operations
- ✓ Appendix D-2: Basic-RNP 1 Job Aid

- ✓ Appendix E-1: AC 91-008 - Aircraft and operators approval for RNP APCH operations
- ✓ Appendix E-2: RNP APCH Job Aid

- ✓ Appendix F-1: AC 91-009 - Aircraft and operators approval for RNP AR APCH operations
- ✓ Appendix F-2: RNP AR APCH Job Aid

- ✓ Appendix G-1: AC 91-010 - Aircraft and operators approval for APV/baro-VNAV operations
- ✓ Appendix G-2: APV/baro-VNAV Job Aid

4.9 Once the task force reviewed and incorporated opportunities for improvement in the CA and job aids provided, the Meeting agreed to make the following conclusion:

Conclusion SAM/IG/4-2 Advisory Circulars for Aircraft approval and operators for RNP 10 operations, RNAV 5, RNAV 1 and 2, Basic RNP 1, RNP APCH, RNP AR APCH and APV/baro-VNAV

That States of ICAO South American Region, according to the PBN implementation plans:

a) use the Advisory Circulars (AC), in developing their acceptable means of compliance of approval of aircraft and operators for RNP 10 operations, RNAV 5, RNAV 1 and 2, Basic RNP 1, RNP APCH, RNP AR APCH and APV/baro-VNAV, that are shown in **Appendices A1, A2, B1, B2, C1, C2, D1, D2, E1, E2, F1, F2, G1 and G2** of this part of the report; and

b) that job aids of aforesaid circulars be incorporated into Inspector's manuals of Operations and airworthiness.

Survey on PBN capacity of the aircraft fleet of the SAM Region

4.10 Regarding the survey on PBN capacity of the aircraft fleet of the SAM Region, the Meeting took note of the progress made in the collection of this information and the status of development of the associated database.

4.11 In this respect, the Meeting was informed that, to date, data on commercial aviation had been received from Argentina, Bolivia, Brazil, Colombia, Chile, Ecuador, Guyana, French Guiana, Uruguay and Peru. **Appendix H** describes the progress made in the completion of the survey.

4.12 In this sense, the Meeting considered that efforts should continue so that each State, through its PBN focal point, could take steps to send information on the PBN capacity of its fleet to the ICAO Regional Office as soon as possible. The information collected by the States should be sent to the Regional Office, if possible, in Excel format.

4.13 The Meeting then analysed the survey and the database generated from the data sent, and considered that it met the initial objectives, and introduced some improvements to the instructions and the survey data. It also considered that the suitability of the data sent should be continuously verified. In this sense, the Meeting considered that each State was responsible for the data it provided and that updates and clarifications should be provided as time went by.

4.14 Within this framework, and to facilitate the updating of the data, the Meeting decided that the file containing the survey of each State should be posted on the webpage of the Office, where each State would have access to the information on its fleet through the use of a code. Thus, each State would be able to update the data and send them by e-mail to the Regional Office.

4.15 Finally, the Meeting analysed the data received, taking into account the existing requirements for RNAV-5 implementation. In this regard, a report was requested on the status of those aircraft that could be certified for RNAV-5, based on the equipment installed. In this regard, the data were processed, taking into account the following:

- Aircraft flying above FL250
- Aircraft with FMS + VOR/DME
- Aircraft with FMS + DME/DME
- Aircraft with FMS + GPS
- Aircraft with GPS

4.16 **Appendix I** contains the reports generated in keeping with the database on the potential RNAV-5 capacity of the regional fleet. Likewise, the Meeting agreed to formulate the following Conclusion:

Conclusion SAM/IG/4-3 Continued data collection about PBN Fleet Capacity in the South American Region

The Meeting considered that:

a) efforts should be continued in order that each State, through its PBN Focal Points, conduct such actions to send, as soon as possible, information, about its PBN fleet capacity to ICAO Regional Office. The information collected by States should, as far as possible, be sent to the Regional Office in a file with Excel format.

b) that each State is responsible for providing data and, as time passes, updates or further details on the submitted data should be made;

c) to facilitate the updating of data, the file of the survey of each state be posted on the website of the SAM Office, in order that each State, through a code, can have access to information on its fleet , and thus can perform the update of the data entered , and send it, via e-mail, to the Regional Office.

Training programme on Advisory Circulars (CAs) related to PBN approvals

4.17 Taking into account the need to train operations and airworthiness inspectors of SAM States on the approval requirements contained in the PBN Advisory Circulars in order to proceed with the agreed implementation, the Meeting was apprised of the proposed training programme on the advisory circulars developed to date.

4.18 The Meeting also considered that the personnel attending the courses would acquire the necessary knowledge to conduct RNAV and RNP approvals, giving authorities two training opportunities in order to increase the number of trained personnel.

4.19 After analysing the proposal, the Meeting agreed to formulate the following Conclusion:

Conclusion SAM/IG/4-4 Training modules on RNAV and RNP approvals

That:

c) The training modules on RNAV and RNP approvals shown in **Appendix J** to this part of the report be approved;

d) Consideration be given to the merging of the two courses, to be given on two separate occasions, on the dates originally foreseen;

e) The Secretariat is requested to study the possibility of providing these courses with fellowships for Project member States and the financial support for their implementation, through Regional Projects RLA/99/901 and RLA/06/901.

Review of work program for the development of Advisory Circulars (AC) related to PBN approvals

4.20 In relation to the work program to continue with the development of the ACs, the Meeting noted the proposed revision to the program.

4.21 In this regard, the Meeting after analyzing the proposal considered that it was appropriate for the purposes of the implementation, and approved the calendar of activities shown in **Appendix K** to this part of the report.

IATA survey on aircraft equipment

4.22 The meeting acknowledged the IATA survey and considers it very useful not only in matters within the PBN implementation, but in the development of CNS ATM in the Region.

APPENDIX A-1

ADVISORY CIRCULAR

AC	**:**	**91-001**
DATE	**:**	**12/10/09**
VERSION	**:**	**Original**
ISSUED BY	**:**	**SRVSOP**

SUBJECT: AIRCRAFT AND OPERATORS APPROVAL FOR RNAV 1O OPERATIONS (DESIGNATED AND AUTHORIZED AS RNP 10)

ADVISORY CIRCULAR

AC	**:**	**91-001**
DATE	**:**	**12/10/09**
VERSION	**:**	**Original**
ISSUED BY	**:**	**SRVSOP**

SUBJECT: AIRCRAFT AND OPERATORS APPROVAL FOR RNAV 1O OPERATIONS (DESIGNATED AND AUTHORIZED AS RNP 10)

1. PURPOSE

This advisory circular (AC) establishes RNP 10 approval requirements for aircraft and operations in oceanic or remote airspace.

An operator may use alternate means of compliance, as far as those means are acceptable for the respective Civil Aviation Authority (CAA).

The future tense of the verb or the term “shall” apply to operators who choose to meet the criteria set forth in this AC.

2. RELEVANT SECTIONS OF THE LATIN AMERICAN AERONAUTICAL REGULATIONS (LAR) OR EQUIVALENT

LAR 91: Sections 91.1015 and 91.1640 or equivalent

LAR 121: Section 121.995 (b) or equivalent

LAR 135: Section 135.565 (c) or equivalent

3. RELATED DOCUMENTS

Annex 2	Rules of the Air
Annex 6	Operation of aircraft
ICAO Doc 9613	Performance-based Navigation (PBN) manual
ICAO Doc 4444	Procedures for air navigation services – Air traffic management
ICAO Doc 7030	Regional Supplementary Procedures
ICAO Doc 8168	Aircraft operations
	Volume II – Parts I and II – General criteria
FAA Order 8400.12A	Required navigation performance 10 (RNP 10) operational approval
EASA AMC 20-12	Recognition of FAA Order 8400.12A for RNP-10 operations
España DGAC CO 01/01	Aprobación operacional y criterios de utilización de sistemas para la navegación en espacio aéreo designado RNP-10
Australia CAAP RNP 10-1	Required navigation performance 10 operational approval

4. DEFINITIONS AND ABBREVIATIONS

4.1 Definitions

a) **Aircraft-based augmentation system (ABAS).-** An augmentation system that augments and(or integrates the information obtained from other GNSS elements with information available on board the aircraft.

b) **Area navigation (RNAV)**.- A navigation method that allows aircraft to operate on any desired flight path within the coverage of ground- or space-based navigation aids, or within the limits of the capability of self-contained aids, or a combination of these.

Note.- Area navigation includes performance-based navigation as well as other RNAV operations that do not meet the definition of performance-based navigation.

c) **Area navigation (RNAV) specification**.- Area navigation specification that does not include the on-board performance control and alerting requirement, designated by the prefix RNAV; *e.g*., RNAV 5, RNAV 2, RNAV 1.

Note 1.- *The Manual on Performance-based Navigation (PBN) (Doc 9613), Volume II, contains detailed guidelines on navigation specifications.*

Note 2.- *The term RNP, formerly defined as "a statement of the navigation performance necessary for operation within a defined airspace", has been deleted from the Annexes to the Convention on International Civil Aviation because the RNP concept has been replaced by the PBN concept. In said Annexes, the term RNP is now only used within the context of the navigation specifications that require on-board performance control and alerting; e.g., RNP 4 refers to the aircraft and the operational requirements, including a lateral performance of 4 NM, with the requirement for on-board performance control and alerting as described in the PBN Manual (Doc 9613).*

d) **Display errors (screen protection system error).-** These errors may include error components contributed by any input, output or signal conversion equipment used by the display as it presents either aircraft position or guidance commands (e.g. course deviation or command heading) and by any course definition entry device employed. For systems in which charts are incorporated as integral parts of the display, the display system error necessarily includes charting errors to the extent that they actually result in errors in controlling the position of the aircraft relative to a desired path over the ground.

To be consistent, in the case of symbolic displays not employing integral charts, any errors in way-point definition, directly attributable to errors in the reference chart used in determining way-point positions, should be included as a component of this error. This type of error is virtually impossible to handle, and in general practice, highly accurate, published way-point locations are used to the greatest extent possible in setting up such systems to avoid such errors and reduce workload.

e) **Fault detection and exclusion (FDE).-** Is a function performed by some on board GNSS receivers, which can detect the presence of a faulty satellite signal and automatically exclude it from the position calculation. In addition to the total number of satellites needed for receiver autonomous integrity monitoring (RAIM), at least one more available satellite is required (6 satellites).

f) **Flight management system (FMS)**.- An integrated system, consisting of an airborne sensor, a receiver and a computer containing both navigation and aircraft performance databases, capable of providing RNAV performance and guidance values to a display and automatic flight control system.

g) **Flight technical error (FTE).-** The FTE is the accuracy with which an aircraft is controlled as measured by the indicated aircraft position, with respect to the indicated command or desired position. It does not include blunder errors.

Note.- *For aircraft that are not capable of autopilot or flight director coupling, an FTE of 3.7 km (2 NM) for oceanic operations must be taken into account in determining any limitations.*

h) **Global navigation satellite system (GNSS)**.- A generic term used by ICAO to define any global position, speed, and time determination system that includes one or more main satellite constellations, such as GPS and the global navigation satellite system (GLONASS), aircraft receivers and several integrity monitoring systems, including aircraft-based augmentation systems (ABAS), satellite-based augmentation systems (SBAS), such as the wide area augmentation systems (WAAS), and ground-based augmentation systems (GBAS), such as the local area augmentation system (LAAS).

Distance information will be provided, at least in the immediate future, by GPS and GLONASS.

i) **Global positioning system (GPS)**.- The United States global navigation satellite system (GNSS) is a satellite-based radio navigation system that uses precise distance measurements to determine position, speed, and time anywhere in the world. The GPS is made up by three elements: the spatial, control, and user elements. The GPS space segment is nominally made up by, at least, 24 satellites in 6 orbital planes. The control element consists of 5 monitoring stations, 3 ground antennas, and one main control station. The user element consists of antennas and receivers that provide the user with position, speed, and precise time.

j) **Navigation system error (NSE).-** The difference between true position and estimated position.

k) **Navigation specifications**.- Set of aircraft and flight crew requirements needed to support performance-based navigation operations in a defined airspace. There are two kinds of navigation specifications:

l) **Oceanic airspace**.- The airspace over the oceanic area is considered international airspace in which ICAO procedures and separations apply. The responsibility for providing air traffic services in this airspace is delegated to those States with the greatest geographic proximity and/or that have more resources available.

m) **Path definition error (PDE).-** The difference between the defined path and the desired path in a given place and time.

n) **Performance-based navigation (PBN)**.- Performance-based navigation specifies system performance requirements for aircraft operating along an ATS route, on an instrument approach procedure, or in a designated airspace.

Performance requirements are defined in terms of the precision, integrity, continuity, availability, and functionality necessary to perform the proposed operation within the context of a particular airspace concept.

o) **Primary means of navigation.-** A navigation system approved for a given operation or flight phase, that must meet precision and integrity requirements but not full availability and continuity of service. Safety is guaranteed by limiting flights to specific time periods and through the establishment of timely restrictive procedures.

p) **Receiver autonomous integrity monitoring (RAIM)**.- A technique used in a GNSS receiver/processor to determine the integrity of its navigation signals, using only GPS signals or GPS signals enhanced with barometric upper-air data. This determination is achieved by a consistency check between pseudo-range measurements. At least one additional available satellite is required with respect to the number of satellites that are needed to obtain the navigation solution.

q) **Required navigation performance (RNP) specification**.- Area navigation (RNAV) specification that includes the on-board performance control and alerting requirement, designated by the prefix RNP; *e.g.,* RNP 4, RNP APCH, RNP AR APCH.

r) **RNAV operations**.- Aircraft operations that use area navigation for RNAV applications. RNAV operations include the use of area navigation for operations that are not performed in keeping with the PBN manual.

s) **RNAV system**.- An area navigation system which permits aircraft operation on any desired flight path within the coverage of ground- or space-based navigation aids or within the limits of the capability of self-contained aids, or a combination of these. An RNAV system may be included as part of a Flight Management System (FMS)

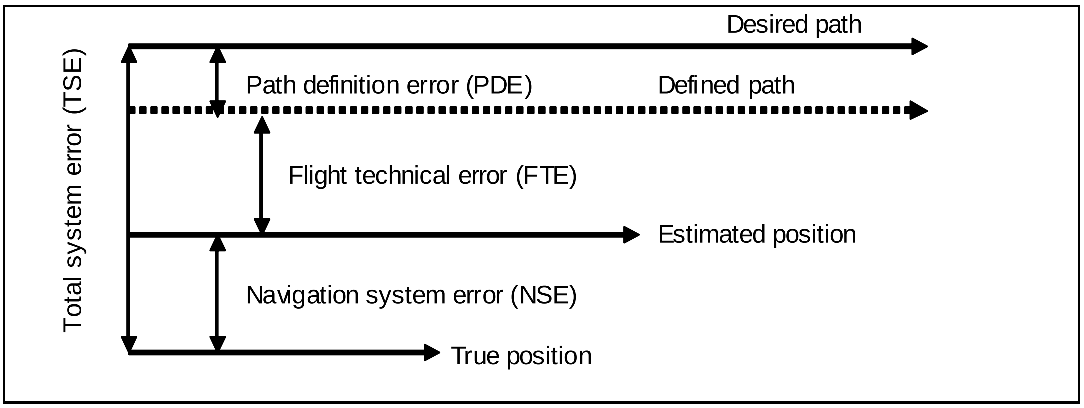
t) **Single means of navigation.-** A navigation system approved for a given operation or flight phase, and that allows the aircraft to meet the four navigation criteria: precision, integrity, availability, and continuity of service.

u) **Stand-alone global positioning system (Stand-alone GPS)**.- A GPS that is not connected to, or combined with, any other navigation system or sensor.

v) **Supplementary means of navigation.-** A navigation system that must be used together with a system considered to be a single means of navigation, and that must meet precision and integrity requirements but not availability and continuity conditions.

w) **Total system error (TSE).-** Is the difference between the true position and the desired position. This error is equal to the vector sum of path definition error (PDE), flight technical error (FTE) and navigation system error (NSE).

Total system error (TSE)



4.2 Abbreviations

a)	CAA	Civil Aviation Administration/Civil Aviation Authority
b)	AC	Advisory circular (FAA)
c)	ACAS/TCAS	Airborne collision avoidance system
d)	AF	Flight manual
e)	AFM	Airplane flight manual
f)	AIP	Aeronautical information publication
g)	AP	Autopilot
h)	AIM	Aeronautical information manual
i)	AMC	Acceptable means of compliance
j)	ATC	Air traffic control
k)	ATS	Air traffic services
l)	BRG/DIS	Bearing/distance
m)	CA/AC	*Circular de asesoramiento* – SRVSOP in spanish/Advisory circular
n)	DME	Distance measuring equipment
o)	DV	Flight dispatcher (spanish abbreviation)
p)	EASA	European Aviation Safety Agency
q)	EUR	ICAO European Region
r)	FAA	United States Federal Aviation Administration
s)	FD	Flight director
t)	FDE	Fault detection and exclusion

u)	FIR	Flight Information Region
v)	FL	Flight level
w)	FMS	Flight management system
x)	FTE	Flight technical error
y)	GBAS	Ground-based augmentation system
z)	GNSS	Global navigation satellite system
aa)	GLONASS	Global navigation satellite system
bb)	GPS	Global positioning system
cc)	INS	Inertial navigation system
dd)	IRS	Inertial reference system
ee)	IRU	Inertial reference unit
ff)	LAAS	Local area augmentation system
gg)	LAR	Latin American Regulations
hh)	LAT/LONG	Latitude/longitude
ii)	LNAV	Lateral navigation
jj)	LOA	Letter of authorisation/letter of acceptance
kk)	LRNS	Long-range navigation system
ll)	MEL	Minimum equipment list
mm)	NAV	Navigation
nn)	NAVAIDS	Navigation aids
oo)	NDB	Non-directional radio beacon
pp)	NM	Nautical mile
qq)	NSE	Navigation system error
rr)	ICAO	International Civil Aviation Organization
ss)	OM	Operations manual
tt)	OpSpecs	Operations specifications
uu)	PANS-OPS	Procedures for Air Navigation Services - Aircraft Operations
vv)	PBN	Performance-based navigation
ww)	PDE	Path definition error
xx)	POH	Pilot operating handbook
yy)	POI	Principal operations inspector
zz)	RAIM	Receiver autonomous integrity monitoring
aaa)	RNAV	Area navigation
bbb)	RNP	Required navigation performance
ccc)	RNP APCH	Required navigation performance approach
ddd)	RNP AR APCH	Required navigation performance authorisation required approach
eee)	SAM	ICAO South American Region

fff)	SAT	South Atlantic
ggg)	SATMA	South Atlantic Monitoring Agency
hhh)	SBAS	Satellite-based augmentation system
iii)	SLOP	Strategic lateral offset procedure
jjj)	SRVSOP	Regional safety oversight cooperation system
kkk)	SSR	Secondary surveillance radar
lll)	STC	Supplementary type certificate
mmm)	TC	Type certificate
nnn)	TSE	Total system error
ooo)	TSO	Technical standard order
ppp)	UIR	Upper flight information region
qqq)	VMC	Visual meteorological conditions
rrr)	VOR	Very high frequency omnidirectional radio range
sss)	WAAS	Wide area augmentation system
ttt)	WATRS	West Atlantic route system
uuu)	WGS	World geodetic system
vvv)	WPT	Waypoint

5. INTRODUCTION

5.1 This AC is entitled RNAV 10 in order to be consistent with the criteria set forth in ICAO Doc 9613 – *Performance-based navigation (PBN) manual*. This new designation and version of this document does not change any requirement nor does it affect operators that have already obtained an RNP 10 approval by the Civil Aviation Authority (CAA).

5.2 The RNAV 10 navigation specification does not require on-board performance monitoring and alerting. However, the designation for airworthiness and operational approvals, as well as airspace and route designations will remain as RNP 10, in order to exempt this publication and the approvals on this matter from complying with the new RNAV 10 designation.

5.3 Recognising that there are airspaces, routes, and airworthiness and operational approvals designated as RNP 10, it is expected that the new denominations of airspace, routes, and aircraft and operator approvals will continue to use such term (RNP 10), while the PBN application will be known as RNAV 10.

5.4 This AC provides orientation and guidance on aspects related to airworthiness and operational approvals. These approvals will allow an operator to obtain a RNP 10 authorisation to operate in oceanic or remote airspaces. Furthermore, this document provides criteria for operators to extend any navigation time limit associated with the RNP 10 approval.

5.5 The implementation of the 50-NM lateral and longitudinal separation minima for oceanic or remote RNP 10 airspaces will result in benefits for the operators in terms of having a greater number of optimum routes, reduced delays, increased flexibility, and cost reduction, without reducing safety. ATS providers will obtain benefits from the efficient use of airspace and increased air traffic flow.

5.6 RNP 10 operations in oceanic or remote areas with no ground-based navigation aids, except for isolated areas, require aircraft navigation to be based on long-range navigation capability with inertial navigation and/or global positioning systems.

5.7 The material described in this AC has been developed base on the following document:

- ✓ ICAO Doc 9613, Volume II, Part B, Chapter 1 – Implementing RNAV 10 (designated and authorized as RNP 10).

5.8 This AC has been harmonised with the following documents:

- ✓ FAA Order 8400.12A - Required navigation performance 10 (RNP 10) operational approval.
- ✓ EASA AMC 20-12 - Recognition of FAA Order 8400.12A for RNP-10 operations
- ✓ España DGAC Circular Operativa 01/01 – Aprobación operacional y criterios de utilización de sistemas para la navegación en espacio aéreo designado RNP-10

6. GENERAL INFORMATION

6.1 Navigation aid infrastructure

a) RNP 10 was developed for operations in oceanic and remote areas and does not require any ground-based navigation infrastructure or assessment.

6.2 ATS communications and surveillance

a) This AC does not address communication or air traffic services (ATS) surveillance requirements that may be specified for operation on a particular route or area. These requirements are specified in other documents, such as the aeronautical information publications (AIP) and ICAO Regional Supplementary Procedures (Doc 7030). Operators and flight crews shall take into account all the operational documents related to RNP 10 airspace required by the CAA before conducting flights in said airspace.

6.3 Obstacle clearance and route spacing

a) Doc 8168 (PANS OPS), Volume II – Procedures for Air Navigation Services: Aircraft Operations provides detailed guidance on obstacle clearance. The general criteria in Parts I and III shall be applied.

b) The rationale for having choosen the RNP 10 value was to support reduced lateral and longitudinal separation minima for aplication in oceanic and remote areas where the availability of navigation aids, communication, and surveillance is limited.

c) The minimum route spacing where RNP 10 is utilized is 50 NM.

6.4 Publications

a) The AIP should clearly indicate that the navigation application is RNP 10, where reference is to existing routes. The route should identify the minimum segments altitude requirements.

b) The navigation data published in the AIP for routes and navigation aids must meet the requirements established in Annex 15 – Aeronautical Information Services. All routes must be based on the coordinates of the world geodetic system (WGS-84).

7. AIRWORTHINESS AND OPERATIONAL APPROVAL

7.1 To obtain RNP 10 authorisation, a commercial air transport operator must comply with two types of approvals:

a) the airworthiness approval granted by the State of registry (see Article 31 of the Chicago Convention and Paragraphs 5.2.3 and 8.1.1 of Annex 6 Part I); and

b) the operational approval, granted by the State of the operator (See Paragraph 4.2.1 and Attachment F to Annex 6 Part I).

7.2 For general aviation operators, the State of registry will determine whether or not the aircraft meets the applicable RNP 10 requirements and will issue the operation authorisation (*e.g*., a letter of authorisation– LOA) (see Paragraph 2.5.2.2 of Annex 6 Part II).

7.3 Before submitting the application, operators shall review all aircraft qualification requirements. Compliance with airworthiness requirements or the installation of the equipment alone does not constitute operational approval.

8. AIRWORTHINESS APPROVAL

8.1 Aircraft requirements

8.1.1 **Navigation systems**.- The RNP 10 navigation specification requires that aircraft operating in oceanic and remote areas be equipped with at least *two independent and serviciable long range navigation systems (LRNS),* comprising an inertial navigation system (INS), an inertial reference system/flight management system (IRS/FMS), or a global navigation satellite system (GNSS) (*e.g*., the global positioning system (GPS)), with an integrity such that the navigation system does not provide an unacceptable probability of misleading information.

8.1.2 **System performance, monitoring and alerting**

a) **Accuracy.-** During operations in airspace or on routes designates as RNP 10, the lateral total system error must not exceed ± 10 NM for at least 95% of the total flight time. This includes positioning error, flight technical error (FTE), path definition error and display error.

The along-track error must also not exceed ± 10 NM for at least 95% of the total flight time.

Note 1.- *For RNP 10 operational approval of aircraft capable of coupling the RNAV system to the flight director (FD) or autopilot (AP), the navigation position error is the main contributing factor to transverse and longitudinal error. FTE, the path definition error, and display errors are considered insignificant for purposes of RNP 10 approval.*

Nota 2.- *When data collection method described en Appendix 1 of FAA Order 8400.12A is used as the basis for an RNP 10 operations approval, these error types are included in the analysis. However, when the data collection method described in Appendix 6 of FAA Order 840012.A is used, these errors are not included since that method is more consevative. The Appendix 6 nethod uses radial error instead of cross-track and along-track error.*

b) **Integrity.-** Malfunctioning of the aircraft navigation equipment is classified as a major failure condition according to airworthiness regulations (*e.g*., 10^{-5} per hour).

c) **Continuity.-** The loss of this function is classified as a major failure condition for oceanic and remote navigation. The continuity requirement is met by carrying two independent LRNS systems on board (excluding signal-in-space).

d) **Signal-in-space.-** If GNSS is used, the aircraft navigation equipment must provide an alert if the probability of signal-in-space errors cause a lateral position error greater than 20 NM to exceed 10^{-7} per hour (Annex 10, Volume I, Table 3.7.2.4.1).

8.2 Aircraft groups (aircraft fleets)

8.2.1 **Aircraft group.-** For an aircraft to be considered part of a group for purposes of RNP 10 airworthiness approval, it must meet the following conditions:

a) the aircraft must have been built following a nominally identical design and must have been approved for the same type certificate (TC), an amendment to a TC, or a supplemental type certificate (STC), as applicable;

Note.- *For derivative aircraft, data from the original configuration could be used to minimise the amount of additional information needed to indicate conformity. The extent of the additional information needed will depend on the category of the differences between the original aircraft and the derivative one, when an INS/IRU is used to meet RNP 10 requirements.*

b) For the navigation system installed in each aircraft to meet the minimum RNP 10 airworthiness approval, it must have been built with the same manufacturer specifications and have the same part numbers.

c) When approval is requested for a group of aircraft, the data package must contain the following information:

1) a list of the group of aircraft to which the information package applies;

2) a list of the routes to be operated and the maximum estimated navigation time in navigation from alignment to the time in which the flight will leave Class II navigation airspace;

3) the compliance procedures to be used to ensure that all aircraft sent for approval meet RNP 10 navigation capabilities for the RNP 10 approved time duration; and

4) the engineering data to be used in order to ensure continuity of RNP 10 service for the RNP 10 approved time duration.

Note.- *Aircraft with INS/IRU systems from different manufacturers or with different part numbers may be considered part of the group if it is demostrated that the navigation equipment provides an equivalent navigation performance.*

8.2.2 **Non-group aircraft**.- Aircraft for which an approval is requested based on the unique characteristics of the navigation system and structure to be used instead of the characteristics common to the group aircraft.

Note.- *The information gathered by one or more operators in accordance with Appendix 6 to FAA Order 8400.12A can be used as the basis for the approval of another operator and may reduce the number of tests required for approval. Appendix 6 to FAA Order 8400.12A contains an example of the data collection procedure and samples of the forms to be used for collecting such information.*

8.3 Determining aircraft eligibility for RNP 10 operations

8.3.1 Aircraft eligibility

Many of the aircraft and navigation systems currently used for oceanic and remote operations are eligible for RNP 10 operations, based on one or more of the provisions included in the current certification criteria. Therefore, an additional aircraft certification may not be needed for most RNP 10 operational approvals. In these cases, a new aircraft certification will only be needed if the applicant chooses to request additional performance, beyond the original certification or the certification declared in the aircraft flight manual (AFM), and when the desired performance cannot be shown through data collection methods. The following three methods for determining aircraft eligibility have been defined:

a) **Method 1 – Aircraft eligibility through RNP certification (aircraft with RNP airworthiness declaration in the AFM)**

1) This method can be used to approve aircraft that have officially been certified and approved for RNP operations.

2) RNP Compliance (conformity or capability) will be documented in the AFM or in its approved supplement and normally is not limited to RNP 10. The AFM will indicate the RNP levels that have been demonstrated and any related provision applicable to their use (for example, navaid sensor requirements). Operational approval of these aircraft will be based on the performance declared in the AFM.

3) An airworthiness approval that specifically indicates RNP 10 performance can be obtained. The following wording can be used in the AFM, when RNP 10 approval is granted by the CAA aircraft certification office for a modification to the INS/IRU certified performance:

"It has been shown that the XXXX navigation system meets the criteria set forth in (State document or guidelines) as primary means of navigation for flights up to XXXX hours with no update. Determination of the duration of the flight begins when the system is set on navigation mode. For flights that include on-board navigation position update, the operator must address the effect that such update has on the precision of the position and of any time limit associated with RNP operations, relative to updates to NAVAIDS used and to the area, routes, and procedures, which shall be used for the flight. Proof of performance according to the provisions set forth in (State document or guidelines) does not entail approval for conducting RNP operations".

Note.- *The AFM wording described above is based on the performance approval by the CAA and is only one of the elements in the approval process. Aircraft whose AFM includes this text shall be eligible for approval through the issuance of OpsSpecs or a Letter of Authorisation (LOA), provided all other criteria have been met. The XXXX hours specified in the AFM do not include updates. When the operator proposes to credit the update, the proposal must indicate the effect that the update has on the accuracy of the position and on any time limit associated to RNP operations, relative to the updates of NAVAIDS used and the area, routes, or procedures to be used for the flight.*

b) **Method 2 – Aircraft eligibility through prior navigation system certification (aircraft without RNP declaration in the AFM)**

Method 2 can be used to grant approval to aircraft whose level of performance, by virtue of other standards or previous standards, can be used as equivalent to the RNP 10 criteria. The standards listed in Paragraphs a) through g) can be used to classify an aircraft. Other standards can also be used if they are sufficient to ensure that the RNP 10 requirements are met. Should other standards be used, the applicant must propose acceptable means of compliance:

1) **Aircraft equipped with dual GNSS approved as a primary means of navigation in oceanic and remote areas**

(a) aircraft approved to use GNSS as a primary means of navigation for oceanic and remote operations, in accordance with the appropriate requirements of the CAA, meet RNP 10 requirements without time limitations;

(b) FAA AC 20-138A or equivalent documents provide an acceptable means of compliance with installation requirements for aircraft that use GNSS, but do not integrate this system with other sensors.

(c) operators who intend to use GNSS as the only navigation system (without INS or IRS) for RNP 10 routes or airspaces must also comply with the regulations and advisory documentation related to the CAA. The applicant or operator must also comply with the specific requirements described in this AC. This includes the use of a GNSS approved as a primary means of navigation for oceanic and remote areas.

(d) the AFM must indicate that a particular GNSS facility meets the appropriate CAA requirements. The authorised dual GNSS equipment must be installed by virtue of a technical standard order (TSO) and an approved programme for FDE availability prediction must be used. The maximum allowable time in which it is forecast that FDE capability will not be available is 34 minutes. The maximum service interruption time must be included as a condition for RNP approval.

Note.- *If the FDE service interruption time for the expected RNP operation is expected to be exceeded, the operation must be re-scheduled for a time when FDE is available or conduct the RNP 10 operation based on an alternate means of navigation.*

2) **Multi-sensor systems integrating GNSS with RAIM, FDE or equivalent system functionality**

(a) multi-sensor systems to which GNSS is integrated with the RAIM, FDE or equivalent system, that have been approved by virtue of the guidance contained in FAA AC 20-130A or equivalent documents, meet the RNP 10 requirements without any limitations of time. In this case, INS or IRU must have been approved in accordance with LAR 121 Appendix G.

3) **Transport aircraft eligible for /E suffix, as defined in the United States aeronautical information manual (AIM)**

(a) Aircraft equipped with INS or IRU, with radio navigation position update and electronic map display, that classify for /E equipment suffix as defined in the United

States AIM, meet all of the RNP 10 requirements for up to 6.2 hours of flight time. Timing starts when the system is set on navigation mode or at the last point where the systems were updated. If the systems are updated en route, the RNP time limit of 6.2 hours must be adjusted after the update to account for the update precision.

***Note.-** The 6.2-hour flight time is based on an inertial system with a 95% radial position error index (circular error index) of 3.7 km/h (2.0 NM/H), which is statistically equivalent to specific 95% cross-track error indices of 2,9678 km/h (1,6015 NM/h) and 95% along-track position error indices (orthogonal error indices) of 18.5 km (10 NM) each, and 95% cross-track and along-track position error limits of 18.5 km (10 NM) each (for example, 18.5 km (10NM) /2,9678 km/h (1,6015 NM/h) = 6,2 hours).*

(b) Aircraft equipment with /E suffix is a designation used by the United States; it is not an ICAO designation and should only be used for flights in the continental United States. Only the suffix in this place is defined in order to determine the requirements to meet that stated in this paragraph.

4) **Aircraft equipped with INS or IRU that have been approved in accordance with LAR 121 Appendix G or equivalent documents**

(a) inertial systems approved in accordance with LAR 121 Appendix G or equivalent documents meet the RNP 10 requirements for up to a flight time of 6.2 hours. Timing begins when the systems are set on navigation mode or at the last point where the systems were updated. If the systems are updated en route, the operator must show the impact that update accuracy has on the time limit. INS accuracy, reliability, and maintenance, as well as flight crew training required according to LAR 121 Appendix G, are applicable to the RNP 10 authorisation.

5) **Aircraft equipped with dual INS or IRU**

(a) When dual INS or IRU is provided as the only long-range means of navigation, the systems must be installed in accordance with CAA standards. A basic time limit of 6.2 hours for RNP 10 is applicable after the systems are set on navigation mode (NAV). The basic time limit of 6.2 hours can be extended based on the methods described in paragraph 8.4.

6) **Aircraft equipped with dual INS or IRU approved for minimum navigation performance specifications (MNPS) operations**

(a) aircraft equipped with dual INS or IRU that have been approved for MNPS meet the RNP 10 requirements up to 6.2 hours after the systems have been set on navigation mode or after an en-route update. If systems are updated en route, the operator must show the impact that accuracy has on the time limit.

7) **Aircraft equipped with a single INS/IRU and a single GNSS approved as primary means of navigation in oceanic and remote areas**

(a) aircraft equipped with a single INS or IRU and a single GNSS are considered to meet RNP 10 requirements without any time limitations. INS or IRU must be approved in accordance with LAR 121 Appendix G. GNSS must be authorised in accordance with TSO-C129 and must have an approved programme for predicting fault detection and exclusion (FDE) availability. The maximum allowable time in which it is expected that FDE will not be available is 34 minutes. The maximum service interruption time must be included as a condition for RNP 10 approval. The AFM must indicate that the specific INS/GNSS facility meets the appropriate CAA requirements.

c) **Method 3 – Eligibility of aircraft through data collection**

1) This method requires operators to collect data during a specified period of time in order to obtain RNP 10 approval. The data collection programme must indicate the navigation accuracy requirements appropriate for RNP 10. Data collection must ensure that applicant can prove to the CAA that the aircraft and the navigation system provide the flight crew with navigation awareness concerning the foreseen RNP 10 route. Data

collection must also provide a clear understanding of navigation system status and that the indications and procedures in case of failure are consistent with the continuing required navigation performance.

2) There are two data collection methods:

(a) **The sequential method.-** This method is a data collection programme that meets the provisions set forth in FAA Order 8400.12A Appendix 1. The sequential method allows operator to collect and plot data in "pass-fail" graphs in order to determine if the aircraft system of the operator will meet RNP 10 requirements as long as needed by the operator; and

(b) **The periodic method.-** This data gathering method requires a GNSS manual receiver as the basis for INS data collection, this is described in FAA Order 8400.12A Appendix 6. The collected data are immediately analysed in order to determine whether or not the system is capable of maintaining RNP 10 as long as needed by the operator.

3) The operator must submit documents relevant to the chosen qualification method so that the CAA can determine if the aircraft is equipped with LRNS that meet RNP 10 requirements (for example, the AFM). The applicant must submit a configuration list with details on the relevant components and equipment to be used for long-range navigation and for RNP 10 operations, and will describe the relationships between such components and equipment. The applicant must indicate the proposed time limit for INS or IRU for RNP 10 operations, and must consider the effect of head winds on the area where RNP 10 operations will be carried out in order to determine the feasibility of the proposed operation.

8.4 Obtaining approval with extended time limit for aircraft equipped with INS or IRU systems

a) The baseline RNP 10 time limit for aircraft equipped with INS and/or IRU systems, once the equipment is set on navigation mode, is *6. 2 hours*, according to the details contained in Paragraphs 8.3.1 b), 3), 4), 5), and 6). The time limit may be extended using any of the following methods:

1) an extended time limit may be established when RNP is integrated to an aircraft navigation system through the documented airworthiness statement in the AFM or its supplement, as described in Paragraph 8.3.1 a). The applicant must submit to the aircraft certification office or equivalent, aircraft certification data showing that the time limit extension for RNP 10 is justified;

2) when an INS or IRU has been approved using an existing approval standard, as detailed in Paragraphs 8.3.1 b), 3), 4), 5), and 6), an extended time limit can be established by an applicant who submits supporting data to the CAA aircraft certification office. Aircraft group approvals will be granted with the appropriate restrictions during aircraft certification, if the data collected show that the approval is warranted; and

3) an applicant may establish an extended time limit using multiple navigation sensors, by showing that the mixed or average navigation position error justifies such extension (for example, triple mixed INS). If the applicant uses a mixed time limit, then the mixed capacity availability must be operational from the take-off (flight dispatch) for flights in RNP 10 airspace or routes. If the mixed or average functionality is not available at the time of take-off, then the applicant must use a time limit that is not mixed. The extended time limit must be validated through a data collection programme and analysis as specified in the next paragraph;

4) when an INS or IRU has been approved using an existing approval standard, operators can establish an extended time limit by applying a data collection programme in accordance with the guidance provided in Appendixes 1 and 6 of FAA Order 8400.12A.

8.5 Continued airworthiness

a) The operators of aircraft approved to perform RNP 10 operations, must ensure the continuity of the technical capacity of them, in order to meet technical requirements established in this AC.

b) Each operator who applies for RNP 10 operational approval shall submit to the CAA of State of registry, a maintenance and inspection program that includes all those requirements of maintenance necessary to ensure that navigation systems continue fulfilling the RNP 10 approval criteria.

c) The following maintenance documents must be revised, as appropriate, to incorporate RNP 10 aspects:

1) Maintenance control manual (MCM);

2) Illustrated parts catalogs (IPC); and

3) Maintenance program.

d) The approved maintenance program for the affected aircrafts should include maintenance practices listed in maintenance manuals of the aircraft manufacturer and its components, and must consider:

1) that equipment involved in the RNP 10 operation should be maintained according to directions given by manufacturer's components;

2) that any amendment or change of navigation system affecting in any way RNP 10 initial approval, must be forwarded and reviewed by the CAA for its acceptance or approval of such changes prior to its implementation; and

3) that any repair that is not included in the approved/accepted maintenance documentation, and that could affect the integrity of navigation performance, should be forwarded to the CAA for acceptance or approval thereof.

e) Within the RNP 10 maintenance documentation should be presented the training program of maintenance personnel, which inter alia, should include:

1) PBN concept;

2) RNP 10 application;

3) equipment involved in a RNP 10 operation; and

4) MEL use.

8.6 Certification measures related to RNP 10

8.6.1 The operator may choose to certify the aircraft navigation performance in accordance with a new standard in order to take advantage of aircraft functions. Credit can be given to an aircraft performance improvement by collecting operational data, in which case certification would not be necessary.

8.6.2 Guidance on the different types of navigation systems is provided in the following paragraphs. The operator will propose an acceptable means of compliance regarding any of the systems that are not indicated below.

a) **Aircraft with INS.-** Aircraft with INS equipment certified under LAR 121 Appendix G or equivalent document, only need a new certification in the case of operators that choose to certify INS accuracy as better than a radial error of 3.7 km (2 NM) per hour. However, the following conditions must apply:

1) the INS performance certification must address all matters concerning continuing required accuracy, including precision and reliability, acceptance trial procedures, maintenance procedures, and training programmes; and

2) the applicant must determine the standard to be used to demonstrate INS performance. It could be a regulation (*i.e.,* LAR 121 Appendix G or equivalent document) or a specification exclusive to the industry or operator. A statement to the AFM must be added, stating the precision standard used for the certification.

b) **Aircraft to which GNSS is added.-** Both U.S.A. FAA AC 20-138A and Australia CAAP 35-1 provide acceptable means of compliance of installation requirements for aircraft that use GNSS, but to which other sensors are not added. FAA AC 20-130A or equivalent describes the acceptable means of compliance for multi-sensor navigation systems to which GNSS is added. Operators who wish to use GNSS in their aircraft as single means of navigation (for example, without INS or IRS) along RNP 10 routes or airspace must also comply with CAA regulations and corresponding advisory documentation, except for some GNSS requirements described in this AC.

8.6.3 **Equipment configuration**

a) The configuration of the equipment used to show the required accuracy must be identical to the configuration specified in the MEL.

b) The configuration of the equipment used to show the required accuracy must be consistent with RNP 10 oceanic and remote airspace. For example, the statistical benefit of estimating position using INS position data filtered with DME data will not be taken into account.

c) The installation design must meet the design standards applicable to the aircraft being modified.

9. OPERATIONAL APPROVAL

Airworthiness approval alone does not authorise an applicant or operator to conduct RNP 10 operations. In addition to the airworthiness approval, the applicant or operator must obtain an operational approval to confirm the suitability of normal and contingency procedures in connection to the installation of a given piece of equipment.

Concerning commercial air transportation, the evaluation of an application for RNP 10 operational approval is done by the State of the operator, in accordance with standing operating rules (*e.g.,* LAR 121.995 (b) and LAR 135.565 (c) or equivalent), supported by the criteria described in this AC.

For general aviation, the evaluation of an application for RNP 10 operational approval is done by the State of registry, in accordance with standing operating rules (*e.g.*, LAR 91.1015 and LAR 91.1640 or equivalent), supported by the criteria described in this AC.

9.1 Operational approval requirements

9.1.1 In order to obtain RNP 10 approval, the applicant or operator will take the following steps, taking into account the criteria established in this paragraph and in Paragraphs 10, 11, 12, and 13:

a) *Airworthiness approval*.- aircraft must have the corresponding airworthiness approvals, pursuant to Paragraph 8 of this AC.

b) *Application*.- The operator will submit the following documentation to the CAA:

1) *RNP 10 operational approval application*;

2) *airworthiness documents concerning aircraft eligibility*.- Documentation showing that the equipment of the proposed aircraft meets the requirements of this AC, as described in Paragraph 8. The operator will submit relevant documentation showing that the aircraft is equipped with long-range navigation systems (LRNS) that meet RNP 10 requirements, for example those parts of the AFM or AFM supplement that contain the airworthiness statement.

3) *description of aircraft equipment*.- The operator will provide a configuration list with details of the relevant components and the equipment to be used in RNP 10 operations. The list

must include the manufacturer, model and version of each GNSS, INS/IRU equipment and software of the installed FMS.

4) *time limit for RNP 10 with INS/IRU (if applicable)*.- The operator must submit documentation that justifies the proposed RNP 10 time limit in connection with the specified INS or IRU. The applicant will take into account the effect of head winds on the area where it plans to conduct RNP 10 operations in order to determine whether or not the proposed operations are viable.

5) *Training Programme for flight crews and flight dispatchers (DV), procedures, and operating practices*

(a) Commercial operators must submit the training curriculum and other appropriate material to the CAA in order to show that the operational procedures and practices and the training aspects identified in Paragraph 12, related to RNP 10 operations, have been included in the training programmes, where applicable (for example, initial, upgrade or recurrent training programmes for flight crews and flight dispatchers). The operator will develop and standardise procedures and practices according to the guidelines established in Paragraph 11, in the following areas: flight planning, aircraft pre-flight procedures for each flight, procedures before entering an RNP 10 route or airspace and in-flight, contingency, and flight crew qualification procedures.

***Note.-** It is not necessary to establish a separate training programme if RNP 10 training, identified in Paragraph 12, has already been included in the operator training programme. However, it should be possible to identify what RNP 10 aspects are covered in a training programme.*

(b) General aviation operators must be familiar and show that they will conduct their operations applying the practices and procedures described in Paragraph 11.

6) *Operations manual and checklist*

(a) LAR 121 and 135 operators.- Commercial operators must review the operations manual (OM) and the checklists in order to include information and guidance on standard operational procedures (SOP) detailed in Paragraph 11 of this AC. The appropriate manuals must contain the operation instructions for navigation equipment and any other procedure established in order to operate in a given operations area (e.g., contingency procedures). The manuals and checklists must be submitted for review along with the formal application in Phase two of the approval process.

(b) LAR 91 operators.- General aviation operators must develop operating instructions for navigation equipment and contingency procedures. This information must be available to crews in the OM or in the pilot operations handbook (POH). These manuals and the manufacturer's instructions for the operation of the aircraft navigation equipment, as appropriate, must be submitted as attachments to the formal application for review of the CAA.

7) *Minimum equipment list (MEL)*.- The operator will send any revision to the MEL that is necessary to conduct RNP 10 operations (*e.g.*, if the approval is based on a "triple mix", the MEL must include the three navigation units that must be operational).

8) *Maintenance*.- All operators must establish, maintain, and submit to the CAA the maintenance programme for each navigation system. For other installations, the operator must submit any change to its maintenance manual for review and acceptance. The operator will provide a procedure to withdraw and then restore RNP 10 operational capability to an aircraft.

9) *Maintenance personnel training programme.-* The operators will submit the corresponding maintenance staff training curricula in accordance with Paragarph 8.5 e).

10) Past performance.- The application will include the operating history of the operator. The

applicant will include the events or incidents in relation to navigation errors in Class II airspace, which have been corrected through changes in the training programmes, procedures, maintenance or aircraft navigation systems used.

11) *Navigation data validation programme*.- If a database is used, the operator will present details about the navigation data validation programme as described in Appendix 1 to this AC.

c) *Training programme*.- Once the amendments to manuals, programmes, and documents submitted have been accepted or approved, the operator will provide the required training to its personnel.

d) *Validation flight*.- The CAA may deem it advisable to perform a validation flight before granting the operational approval. Such validation can be performed on commercial flights. The validation flight will be carried according to the provisions of Chapter 13, Volume II, Part II of the SRVSOP Operations Inspector Manual (MIO).

e) *Issuance of an authorisation to conduct RNP 10 operations*.- Once the operator has successfully completed the operational approval process, the CAA will grant the operator the authorisation to conduct RNP 10 operations.

1) LAR 121 and/or 135 operators.- For LAR 121 and/or LAR 135 operators, the CAA will issue the corresponding operations specifications (OpSpecs) that will reflect the RNP 10 authorisation.

2) LAR 91 operators.- For LAR 91 operators, the CAA will issue a letter of authorisation (LOA).

10. OPERATIONAL REQUIREMENTS

10.1 Navigation performance

a) All aircraft must meet a lateral and longitudinal precision equal to or better than ± 10 NM for 95% of the flight time in RNP 10 airspace.

10.2 Navigation equipment

a) All aircraft performing RNP 10 operations in oceanic and remote airspace must be equipped with *two LRNS*, independent and operational, made up by one INS, one IRS/FMS or one GNSS (*e.g.*, a GPS), with such an integrity that will prevent the navigation system from providing error-inducing information.

b) The CAA may approve the use of a single LRNS under specific circumstances (*e.g.*, in the North Atlantic MNPS airspace).

10.3 Flight plan designation

a) Operators must indicate their capability to meet RNP 10 for the route or airspace, in accordance with the *Procedures for Air Navigation Services – Rules of the Air and Air Traffic Services (PANS-RAC Doc 4444),* Appendix 2, Box 10: equipment. The letter "R" must be inserted in Box 10 of ICAO flight plan to indicate that the pilot has:

1) reviewed the foreseen flight route, including the routes to the alternate aerodrome in order to determine the types of RNP involved;

2) confirmed that operator and aircraft have been approved by the CAA for RNP operations; and

3) confirmed that the aircraft can operate in accordance with RNP (RNAV) requirements in the foreseen flight route, including the routes to the alternate aerodrome.

b) Operators applying to use WATRS plus airspace will also insert the letter "Z" in Box 10 and "NAV/RNP 10" in Box 18.

10.4 Availability of navigation aids (NAVAIDS)

At the time of dispatch or during flight planning, the operator must ensure NAVAIDS are available en route to enable the aircraft to navigate to RNP 10 for the duration of the planned RNP 10 operation.

10.5 Evaluation of routes for RNP 10 time limits - Aircraft equipped only with INS or IRU

a) An RNP 10 time limit must be established for aircraft equipped only with INS or IRU. When planning operations in areas where RNP 10 is applied, the operator must establish that the aircraft will comply with the time limits along the routes to be flown.

b) When performing this evaluation, the operator must take into account the effect of headwinds and, in the case of aircraft not capable of coupling the navigation system or the FD to the AP, the operator may choose to make this evaluation each time or for every flight. During the evaluation, the operator must take into account the following items:

1) **Route evaluation.-** The operator must establish that the aircraft can meet RNP time limits for dispatch or departure to RNP10 airspace.

2) **Star point for calculation.-** The calculation must start when the system is set on navigation mode or at the last point where the system is expected to be updated.

3) **Stop point for calculation.-** The stop point for calculation may be one of the following:

(a) the point where the aircraft will begin to navigate by reference to ICAO standard navigation aids (VOR, DME, non-directional beacon (NDB)) or will enter into radar surveillance of an air traffic control (ATC); or

(b) the first point where the system is expected to be updated.

4) **Sources of wind component data**

The headwind component to be considered for the route can be obtained from any source deemed acceptable by the CAA. The following sources of wind data are deemed acceptable: the meteorological office of each State, the national weather service, an industry source, such as Boeing winds on world air routes and historical data provided by the operator.

5) **One-time calculation, based on 75 per cent probability wind components**

Some sources of wind data indicate the annual probability of a given wind component occurring along the routes between pair cities. If an operator decides to make RNP 10 time limit compliance calculations every time, the operator may apply the 75% annual probability to calculate the effect of head winds (it has been shown that this level is a reasonable estimation of the intensity of wind components).

6) **Calculation of the time limit for each specific flight**

The operator may decide to evaluate each specific flight, applying flight plan winds to determine whether or not an aircraft will comply with the specified time limit. If it is determined that it will exceed such time limit, the aircraft must then fly an alternate route or delay the flight until it can meet the established time limit. This evaluation is a flight planning or dispatch task.

10.6 Effect of en-route updates (increased duration of RNP 10 navigation capability)

a) Operators may increase the duration of the RNP 10 navigation capability through position updating procedures. Approvals for various updating procedures are based upon the baseline for which they have been approved minus the time factors shown below:

1) automatic update using dual distance-measuring equipment (DME/DME) = baseline minus 0.3 hours (for example, an aircraft that has been approved for 6.2 hours can gain another 5.9 hours after an automatic DME/DME update);

2) automatic update using distance-measuring equipment and very high frequency omnidirectional radio beacon (DME/VOR) = baseline minus 0.5 hours; and

3) manual update using a CAA-approved method = baseline minus 1 hour. A method similar to the one shown in Appendix 7 to FAA Order 8400.12A can be used.

10.7 Conditions under which automatic radio position update is considered acceptable for flights in RNP 10 airspace

a) The automatic updating is any updating procedure that does not require the flight crew to manually insert coordinates. Automatic update is considered acceptable for operations in RNP 10 airspace, provided:

1) automatic updating procedures are included in the training programme of the operator;

2) fight crews are familiar of the update procedures and the effect of the update on the navigation solution; and

3) an acceptable procedure for automatic update can be used as the basis for an RNP 10 approval with extended time, as indicated by the data submitted to the leader of the CAA team responsible for the approval or to the principal operations inspector (POI). These data must clearly indicate the accuracy of the update and the effect of the update on the navigation capabilities for the remaining flight time.

10.8 Condition under which manual radio position update is considered acceptable for flights in RNP 10 airspace

a) If manual updating has not specifically been approved, manual radio position updates are not allowed for RNP 10 operations. Manual radio position updates may be considered acceptable for RNP 10 airspace operations, provided that:

1) the CAA examines the manual update procedures on a case by case basis. FAA Order 8400.12A Appendix 7describes an acceptable manual update procedure and may be used as the basis for RNP 10 approval for an extended time when the update is supported by acceptable data;

2) operators show that their updating procedures and training procedures include measures/crosschecking to prevent human factors errors, and the CAA determines that the flight crew qualification segment provides them with effective training; and

3) operators provide data to determine the accuracy with which the aircraft navigation system can be updated using manual procedures and navigation aids. Data showing the accuracy achieved during operations must be provided. This factor must be taken into account when establishing the RNP 10 time limit, with INS or IRU.

11. OPERATING PROCEDURES

11.1 In order to meet the requirements for RNP 10 operations in oceanic or remote areas, an operator must comply with the relevant requirements contained in Annex 2 – Rules of the Air, to the Convention on International Civil Aviation.

a) **Flight planning.-** During flight planning, flight crews and flight dispatchers must pay particular attention to conditions that may affect operations in RNP 10 airspace or routes, including:

1) verifying if aircraft has been approved for RNP 10 operations;

2) verifying that two LRNS are operational;

3) verifying if the RNP 10 time limit has been taken into account (only aircraft equipped with INS or IRU);

4) verifying the requirements for GNSS, such as FDE, if applicable to the operation;

5) verifying if the letter “R” has been inserted in Box 10 of the ICAO flight plan (also insert

the letter Z in that same box, and NAV/RNP 10 in Box 18 for WATRS plus spaces);

6) if required, taking into account any operational restriction related to RNP 10 approval for a specific navigation system; and

7) verifying the planned flight route, including the deviation to any alternate aerodrome, in order to identify the existing RNP types.

b) **Pre-flight procedures.-** The following actions must be completed during pre-flight:

1) review flight technical records (maintenance logs) to ascertain the conditions of the equipment required for flight in RNP 10 airspace or route. Ensure that maintenance actions have been taken to correct defects in the required equipment;

2) during the external inspection of the aircraft, check the condition of the navigation antennas and the condition of the fuselage skin around each of these antennas (this can be done by a competent and authorised person other than the pilot, like, for instance, an on-board mechanic or a maintenance person); and

3) review the emergency procedures for operations in RNP 10 airspace or routes. These are not different from the normal oceanic emergency procedures, with one exception: crews must be capable of recognising, and the ATC must be notified, when the aircraft is no longer capable of flying at its capacity level according to the RNP 10 approval.

c) **En-route procedures.-** The following must be observed:

1) at the oceanic point of entry, at least two LRNS must be capable of navigating in RNP 10, otherwise, the crew will consider using an alternate route or initiating a deviation to repair the systems;

2) before entering oceanic airspace, aircraft position must be checked as accurately as possible using external navigation aids. This may require DME/DME or VOR checks to identify navigation system errors by comparing displayed and actual positions. If it is necessary to update the system, the appropriate procedures must be followed with the assistance of a prepared checklist;

3) operating procedures must include mandatory cross-check procedures in order to identify navigation errors in advance and prevent the aircraft from inadvertently deviating from the routes authorised by the ATC;

4) crews must notify the ATC of any degradation or failure of the navigation equipment below the navigation performance requirements, or of any deviation required for a contingency procedure; and

5) pilots must use a lateral deviation indicator, an FD or an AP in lateral navigation mode (LNAV) for RNP 10 operations. All pilots are expected to follow the route centreline, as represented on the on-board lateral deviation indicators and/or flight guidance, during all RNP 10 operations, unless authorised by the ATC to deviate or due to an emergency. For normal operations, the cross-track error/deviation (the difference between the path estimated by the RNP system and the position of the aircraft relative to the path) must be limited to ± ½ the navigation precision associated with the flight route (*e.g.*, 5 NM). Small lateral deviations from this requirement are allowed (*e.g.*, overshooting or undershooting the path) during or immediately after an en-route turn, up to a maximum of 1 times (1xRNP) the navigation precision (*e.g.*, 10 NM).

Note.- *Some aircraft do not show or do not estimate a path during turns. Pilots of such aircraft may not be capable of meeting the ± ½ precision requirement during en-route turns; however, they are expected to meet interception requirements after the turn or in the straight segments.*

d) Contingency procedures

1) Flight crews and flight dispatchers must become familiar with the following general provisions:

(a) if an aircraft cannot continue the flight in accordance with the current ATC authorisation or cannot mantain RNP 10 precision, it will not enter, or continue operations in RNP 10 airspace. In this case, the pilot will obtain a revised authorisation, whenever possible, before beginning any action.

(b) in all cases, the flight crew must follow the contingency procedures established for each region or area of operation (*e.g.*, South Atlantic (SAT), West Atlantic Route System (WATRS), Pacific, etc.) and obtain an authorisation from the ATC as soon as possible.

2) *Procedures for in-flight contingencies, deviations due to weather, and strategic lateral offset*.- The operator will develop procedures for in-flight contingencies, deviations due to weather conditions, and strategic lateral offset (SLOP), in accordance with Paragraph 15.2 of ICAO Doc 4444 – Special procedures for In-flight contingencies in oceanic airspace. These procedures are of general application in oceanic and remote continental areas of operations. As a minimum, the following aspects will be included:

(a) Special procedures for in-flight contingencies in oceanic airspace.

(1) Introduction.

(2) General procedures.

(3) Extended range operations by aeroplanes with two turbine power-units (ETOPS).

(b) Deviation procedures due to weather conditions.

(1) General.

(2) Measures to be adopted when establishing pilot-controller communications.

(3) Measures to be adopted if a revised ATC authorisation cannot be obtained.

(c) Strategic lateral offset procedure in oceanic and remote continental airspaces.

12. TRAINING PROGRAMME

12.1 The following aspects must to be standardised and included in the training programmes for flight crews and flight dispatchers. Some aspects may have already been duly standardised in the existing training programmes. The new technologies may also eliminate the need for certain actions by the flight crew. If this is the case, this paragraph can be deemed fulfilled.

a) Commercial operators (LAR 121 and 135 or equivalents).- Commercial operators must make sure that flight crews and flight dispatchers are trained on the following aspects:

1) General

(a) RNP definition relative to RNP 10 requirements.

(b) Knowledge of the airspace where RNP 10 is required.

(c) Aeronautical charts and documents that reflect RNP 10 operations.

(d) Required equipment and their operation for operations in RNP 10 airspace.

(e) Limitations associated with navigation equipment.

(f) Impact of updating navigation systems.

(g) Use of MEL.

2) Operational procedures

(a) Flight planning.

(b) Pre-flight procedures.

(c) En-route operations.

(d) Contingency procedures.

(e) Aspects contained in this AC.

b) Private operators (LAR 91 or equivalent).- Private operators must provide evidence to the CAA that the pilots have knowledge about RNP 10 operations. When determining whether or not the training of a private operator is appropriate, the CAA may:

1) accept a certificate issued by a training centre without any further evaluation;

2) assess a training programme before accepting a certificate issued by a given training centre;

3) accept a statement in the application of the operator indicating that the operator guarantees and will continue to guarantee that the flight crews have knowledge about RNP 10 operational practices and procedures; and

4) accept a statement from the operator in the sense that it has already performed or will perform a specific RNP 10 training programme.

13. NAVIGATION DATABASE

13.1 If there is an on-board database, it must be valid and appropriate for operations and must include navigation aids and waypoints (WPT) required for the route.

a) The operator must obtain the navigation database from a qualified supplier.

b) Navigation database supplier must have a letter of acceptance (LOA) in order to process navigation information (*e.g.*, FAA AC 20-153 or document on conditions for the issuance of letters of acceptance to navigation data supplier by the European Aviation Safety Agency (EASA IR 21 Subpart G) or equivalent documents). A LOA recognises as data supplier one whose information quality, integrity, and quality management practices are consistent with the criteria in document DO-200A/ED-76. The data base supplier of an operator must have a Type 2 LOA and its respective suppliers must have a Type 1 or 2 LOA. The CAA may accept an LOA issued to navigation data suppliers or may issue its own LOA.

c) The operator must report to the navigation data suppliers any discrepancies that invalidate a route, and prohibit the use of the affected procedures through a notice to the flight crews.

d) Operators must consider the need to conduct periodic checks of the navigation databases in order to maintain the existing quality system or safety management system requirements.

14. OVERSIGHT, INVESTIGATION OF NAVIGATION ERRORS AND WITHDRAWAL OF RNP 10 AUTHORISATION

a) The operator will establish a procedure to receive, analyse, and follow up on navigation error reports in order to determine appropriate corrective actions.

b) Information showing the potential of repeated errors may require changes to the training programme of the operator.

c) Information attributing multiple errors to a specific pilot may indicate that that pilot needs additional training or a revision of his/her license.

d) Repeated navigation errors attributed to a piece of equipment or a specific part of that piece of equipment or to operational procedures can entail the cancellation of an operational approval (withdrawal of RNP 10 authorisation from the OpSpecs or withdrawal of the LOA in the case of private operators).

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APPENDIX 1

NAVIGATION DATA VALIDATION PROGRAMME

1. INTRODUCTION

The information stored in the navigation database defines the lateral and longitudinal guidance of the aircraft for RNP 10 operations. Navigation database updates are carried out every 28 days. Navigation data used in each update are critical for the integrity of each RNP 10 route. This appendix provides guidance on the procedures applied by the operator to validate the navigation data associated with RNP 10 operations.

2. DATA PROCESSING

a) The operator will identify in its procedures, the person responsible for the update of the navigation data.

b) The operator must document a process for accepting, checking, and loading navigation data to the aircraft.

c) The operator must put its documented data process under configuration control.

3. INITIAL DATA VALIDATION

3.1 The operator must validate each RNP 10 route before flying under instrument meteorological conditions (IMC) to ensure compatibility with its aircraft and to ensure that the resulting paths correspond to the published routes. As a minimum, the operator must:

a) compare the navigation data of the routes to be loaded in the FMS with a current map containing the published routes.

b) validate the navigation data loaded for the routes, whether in the flight simulator or in the aircraft, under visual meteorological conditions (VMC). The routes outlined in a map display must be compared to the published routes. The complete routes must be flown to ensure that the paths can be used, that there are no apparent lateral or longitudinal path disconnections, and that they are consistent with the published routes.

c) after validating the routes, a copy of the validated navigation data must be kept and stored in order to compare them to subsequent data updates.

4. DATA UPDATE

Once the operator receives a navigation data update and before using such data in the aircraft, the operator must compare said update with the validated routes. This comparison must identify and solve any discrepancy in the navigation data. If there are significant changes (any change affecting the path or performance of the routes) in any part of a route, and said changes are checked with the initial data, the operator must validate the amended route in accordance with the initial data validation.

5. NAVIGATION DATA SUPPLIERS

Navigation data suppliers must have a Letter of Acceptance (LOA) in order to process these data (for example: FAA AC 20-153 or the document on conditions for the issuance of letters of acceptance for navigation data providers by the European Air Safety Agency– EASA (EASA IR 21 Subpart G) or equivalent documents). A LOA recognises the data supplier as one whose data quality, integrity and quality management practices are consistent with the criteria of document DO-200A/ED-76. The database supplier of an operator must have a Type 2 LOA and their respective suppliers must have a Type 1 or 2 LOA. The CAA may accept a LOA issued to navigation data suppliers or may issue its own LOA.

6. AIRCRAFT MODIFICATIONS (DATA BASE UPDATE)

If an aircraft system required for RNP 10 operations is modified (for example, change of software), the operator is responsible for the validation of the RNP 10 routes based on the navigation data and on the modified system. This can be done without any direct evaluation if the manufacturer verifies that the modification has no effect on the navigation database or on path calculations. If there is no such verification by the manufacturer, the operator must carry out an initial validation of the navigation data with the modified system.

APPENDIX 2

RNP 10 APPROVAL PROCESS

a) The RNP 10 approval process consists of two kinds of approvals: the airworthiness and the operational approvals. Although both have different requirements, they must be considered under a single process.

b) This process is an organised method used by the CAA to ensure that applicants meet the established requirements.

c) The approval process is made up by the following phases:

1)	Phase one:	Pre-application
2)	Phase two:	Formal application
3)	Phase three:	Documentation evaluation
4)	Phase four:	Inspection and demonstration
5)	Phase five:	Approval

d) In *Phase one - Pre-application*, the CAA invites the applicant or operator to the pre-application meeting. At this meeting, the CAA informs the applicant or operator about all the operational and airworthiness requirements it must meet during the approval process, including the following:

1) the contents of the formal application;

2) the review and evaluation of the application by the CAA;

3) the limitations (if any) applicable to the approval; and

4) the conditions under which the RNP 10 approval could be cancelled.

e) In *Phase two – Formal application*, the applicant or operator submits the formal application, together with all the relevant documentation, as established in paragraph 9.1.1 b) of this CA.

f) In *Phase three – Documentation evaluation,* the CAA analyses all the documentation and the navigation system in order to determine its eligibility and what approval method is to be applied regarding the aircraft. As a result of this analysis and evaluation, the CAA may accept or reject the formal application together with the documentation.

g) In *Phase four – Inspection and demonstration*, the operator will provide training for its personnel and perform the validation flights, if so required.

h) In *Phase five - Approval*, the CAA issues the RNP 10 authorisation, once the operator has met the airworthiness and operational requirements. For LAR 121 and 135 operators, the CAA will issue the OpSpecs, and for LAR 91 operators, it will issue an LOA.

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APPENDIX 3

EXAMPLE OF RNP 10 APPROVAL APPLICATION FORM

(company letterhead)

[*Date]*
Mr./Ms. [*Name of DCA*]
[*Position of DCA*]

Dear Mr./Ms.,

This letter is to request RNP 10 operational approval for the South Atlantic (SAT) Corridor based on compliance with the requirements established in CA 91-001. Below you will find detailed information for the requested approval.

a) Aircraft

Make/Model/Series	Registration	Hexadecimal SSR code	Description of RNP 10 equipment (number, make, model, etc). Indicate if aircraft belongs to a group or no group

b) Time limit requested for RNP 10 operation: Hours. ……. No limit ……

(attach supporting documentation)

c) Time interval where no FDE will be provided for GNSS equipment (maximum allowed time: 34 minutes)

Minutes……... Not applicable…………

d) The following documentation is attached:

- ❑ Flight Manual/ Supplement containing the RNP 10 airworthiness statement, or equivalent.
- ❑ Request for approval of MEL revision that includes the necessary systems for RNP 10 operations; or
- ❑ MEL that includes the systems necessary for RNP 10 operations, with the approval of the corresponding revision.
- ❑ Proposed modification of the operations manual that includes the RNP 10 operation in the SAT corridor; or
- ❑ Operations manual that includes the operation in the SAT corridor, with the approval of the corresponding revision.
- ❑ Proposed approval of the training programme for the flight crew, flight dispatchers, and maintenance personnel that includes the RNP 10 operation in the SAT corridor; or
- ❑ Training programme for the flight crew, flight dispatchers, and maintenance personnel that includes the RNP 10 operation in the SAT corridor, with the approval of the corresponding revision.
- ❑ Copy of the documentation showing that a maintenance programme has been established for the equipment necessary for the RNP 10 operation.

Note.- This form is only an example. To complete all the documentation required by this AC, please see Paragraph 9.1.1

(Signature)
(Name and position)
Operations Director

APPENDIX 4

EXAMPLE OF RNP 10 OPERATIONAL APPROVAL LETTER

(CAA letterhead)

RNP 10 OPERATIONAL APPROVAL FOR THE EUROPE/SOUTH AMERICA (EUR/SAM) CORRIDOR

[*Date]*
Mr. /Ms. [*Name of operator representative*]
[*Title*]

Dear Mr./Ms.

Upon evaluation of your request, this CAA grants RNP 10 operational approval for the EUR/SAM corridor, pursuant to SRVSOP CA 91-001 dated 18 August 2009 and to ICAO Regional Supplementary Procedures (Doc 7030/4). This approval is only valid for the following aircraft.

Operator	Company
Fleet	Model
Serial number	Serial number
Registration	Registration number
Associated equipment	
Time limit	

(Signature)
(Name and position)

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APPENDIX 5

EXAMPLE FORM FOR REPORTING NAVIGATION ERRORS IN EUR/SAM CORRIDOR

<table>
<tr><td colspan="5">NAVIGATION ERROR INVESTIGATION FORM</td></tr>
<tr><td colspan="5">Type of report PILOT – Flight:
ATC CONTROLLER:</td></tr>
<tr><td>Date/UTC time</td><td colspan="4">Type of error LATERAL (A to G) (*)
LATERAL (A to O)</td></tr>
<tr><td colspan="5">Reasons METEOROLOGY (see 2 G):
Other (Specify):</td></tr>
<tr><td colspan="5">Conflict alerting systems:</td></tr>
<tr><td>DATA</td><td colspan="2">First aircraft</td><td colspan="2">Second aircraft (only vertical error)</td></tr>
<tr><td>Identification</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Operator</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Type</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Origin</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Destination</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Route segment</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td rowspan="2">Flight level</td><td>Assigned</td><td>Current</td><td>Assigned</td><td>Current</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>Magnitude and direction of the deviation (NM lateral; feet vertical)</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Duration</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Position where the error was observed
(BGR/DIS to fix or LAT/LONG)</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Action by the crew/ATC</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Other comments</td><td colspan="2"></td><td colspan="2"></td></tr>
</table>

(*) See deviation classification

Send to the South Atlantic Monitoring Agency (SATMA)

Fax: + 34-928-577052 e-mail: satma@aena.es

APPENDIX 5 (Continued)

INSTRUCTIONS FOR COMPLETING THE FORM

- As many boxes as possible must be filled.
- Complementary data may be attached to the form.
- The navigation error notifications, as much as possible, will have the following classification:

1. Altitude (vertical) deviations

A. Contingency due to engine failure

B. Contingency due to pressurisation failure

C. Contingency due to other reasons

D. Failure in the assigned climb/descent

E. Climb/descent without ATC assignment

F. Entry into airspace at an incorrect flight level

G. ATC reallocation of flight level (FL) with loss of longitudinal/lateral separation

H. Deviation due to the airborne collision avoidance system (ACAS II/TCAS II)

I. Impossibility to maintain FL

J. Other

2. Lateral deviations

A. Aircraft without RNP approval

B. ATC system loop error

C1. Control equipment error, including unnoticed waypoint (WPT) error

C2. WPT insertion error due to incorrect position input

D. Other, with sufficient pre warning to ATC to receive corrective instructions

E. Other, without enough pre warning to ATC

F. Other, with failure reported/received by the ATC

G. Lateral deviations due to weather, with no possibility of receiving ATC authorisation.

Note.- The EUR/SAM corridor includes the Recife (Atlantic), Oceanic Dakar, Oceanic Sal, and the Canary Islands Flight Information Regions/Upper Information Regions (FIRs/UIRs).

APPENDIX A-2

RNAV 10 (DESIGNATED AND AUTHORIZED AS RNP 10) JOB AID

APLICATION TO CONDUCT RNP 10 OPERATIONS

RNAV 10 (DESIGNATED AND AUTHORIZED AS RNP 10) JOB AID

APLICATION TO CONDUCT RNP 10 OPERATIONS

1. Introduction

This Job Aid was developed by the Latin American Regional Safety Oversight Cooperation System (SRVSOP) to provide States, operators, and inspectors with guidance on the process to be followed by an operator in order to obtain an RNP 10 authorization. RNAV 10 maintains the designation RNP 10, as specified in ICAO Doc 9613 – Performance-based navigation (PBN) manual.

2. Purposes of the Job Aid

2.1 To give operators and inspectors information on the main RNP 10 reference documents.
2.2 To provide tables showing the contents of the application, the associated reference paragraphs, the place in the application of the operator where RNP 10 elements are mentioned and columns for inspector comments and follow-up on the status of various RNP 10 elements.

3. Actions Recommended for the inspector and operator

Some recommendations for use of the Job Aid follow:

3.1 At the pre-application meeting with the operator, the inspector reviews the "basic events of the RNP 10 approval process"described in Part 1 of this Job Aid, in order to provide an overview of the approval process events.
3.2 The inspector reviews this Job Aid with the operator in order to establish the form and content of the RNP 10 approval application.
3.3 The operator uses this Job Aid as a guide to collect the documents/annexes of the RNP 10 application.
3.4 The operator inserts in the Job Aid references showing in what part of its documents are the RNP 10 programme elements located.
3.5 The operator submits the Job Aid and the application to the inspector (documents/annexes).
3.6 The inspector indicates in the Job Aid whether an item is in compliance or needs corrective action.
3.7 The inspector informs the operator as soon as possible when a corrective action by the operator is required.
3.8 The operator provides the inspector with the revised material when so requested.
3.9 The CAA provides the operator with the operational specifications (OpSpecs) or a letter of authorisation (LOA), as applicable, when the tasks and documents have been completed.

4. Structure of the Job Aid

5. Main sources of documents, information and contacts

Advisory Circular CA 91-001 is available on the ICAO/SAM Regional Office web page (www.lima.icao.int) through the SRVSOP link.

6. Main reference documents

Reference Documents	Title
Annex 6	Operation of aircraft
ICAO Doc 9613	Manual on performance-based navigation
FAA Order 8400.12A	Required navigation performance 10 (RNP 10) operational approval
AMC 20-12	Recognition of FAA Order 8400.12A for RNP 10 operations
Spain DGAC CO 01/01	Aprobación operacional y criterios de utilización de sistemas para la navegación en espacio aéreo designado RNP 10
AMC 20-5	Acceptable means of compliance for airworthiness approval and operational criteria for the use of the NAVSTAR Global positioning system (GPS)
AC 20-130()	Airworthiness approval of multi-sensor navigational system for use in the U.S. National Airspace System
AC 20-138A	Airworthiness approval of Global navigation satellite system (GNSS) equipment
AC 25-4	Inertial navigation system (INS)
AC 25-15	Approval of FMS in transport category airplanes
AC 90-45A	Approval of area navigation systems for use in the U.S. National Airspace System

PART 1: GENERAL INFORMATION

Basic events of the RNP 10 approval process

	Action by the Operator	Action by the CAA
1	Establishes the need to obtain RNP 10 authorization.	
2	Reviews the AFM, AFM supplement or Type Certificate Data Sheet (TCDS), or other appropriate documents (*e.g.,* service bulletins (SB), service letters (SL), etc.) to determine the eligibility of the aircraft for RNP 10 operations. The operator contacts the aircraft or avionics manufacturer, if necessary, to confirm RNP 10 or better eligibility of the aircraft.	
3	Contacts the CAA to schedule a pre-application meeting to discuss the operational approval requirements.	
4		During the pre-application meeting, establishes: • the form and contents of the application; • the documents that support RNP 10 approval • the date in which the application will be submitted for evaluation • if necessary, conducts a validation flight observed by the CAA.
5	Submits the application at least 60 days before the start-up of RNP 10 operations.	
6		Reviews the operator submission
7	Once the amendments to manuals, programmes, and documents have been approved, provides training to flight crews, flight dispatchers, and maintenance personnel, and conducts a validation flight, if required by the CAA.	Only if required, participates in the validation flight.
8		Once the operational and airworthiness requirements have been met, issues the operational approval in the form of OpSpecs for LAR 121 or 135 or equivalent operators, or an LOA for LAR 91 or equivalent operators, as appropriate.

Notes related to the approval process

1. **Responsible authority**

   a. **Commercial air transport (LAR 121 and/or 135 or equivalent regulations).-** The **State of registry** determines that the aircraft meets the airworthiness requirements. The **State of the operator** issues the RNP 10 approval (*e.g.,* OpSpecs).

   b. **General aviation (LAR 91 or equivalent regulations).-** The **State of registry** determines that the aircraft meets the airworthiness requirements and issues the operational approval (*e.g.,* an LOA).

2. The CAA does not need to issue an LOA or an equivalent document for each individual area of operation in the case of LAR 91 operators.

3. LAR 121 and/or 135 operators with RNP 10 approval must list the individual areas of operation in the OpSpecs.

4. Related sections of the Latin American Aeronautical Regulations (LAR) or equivalent regulations

   a. LAR 91 Sections 91.1015 and 91.1640 or equivalents

   b. LAR 121 Section 121.995 (b) or equivalent

   c. LAR 135 Section 135.565 (c) or equivalent

5. Related ICAO Documents

   a. Annex 2 to the Convention on International Civil Aviation – Rules of the Air

   b. Annex 6 to the Convention on International Civil Aviation – Operation of Aircraft

   c. OACI Doc 9613 – Performance-based navigation (PBN) Manual

   d. OACI Doc 4444 – Procedures for air navigation services – Air traffic management.

   e. OACI Doc 7030 – Regional supplementary procedures

PART 2: INFORMATION ON THE IDENTIFICATION OF AIRCRAFT AND OPERATORS

NAME OF THE OPERATOR: ____

Aircraft manufacturer, model and series	Registration numbers	Serial numbers	Long-range navigation systems (LRNS) Number, manufacturer and model	RNP specification

DATE OF PRE-APPLICATION MEETING____

DATE IN WHICH THE APPLICATION WAS RECEIVED____

DATE IN WHICH THE OPERATOR INTENDS TO BEGIN RNP 10 OPERATIONS _______________________

IS THE CAA NOTIFICATION DATE APPROPRIATE? YES _____ NO _____

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PART 3 – OPERATOR APPLICATION (ANNEXES AND DOCUMENTS)

Annex	Title of Annex/document	Indication of inclusion by the operator	Comments by the Inspector
A	**Operator letter requesting RNP 10 authorization**		
B	**Group of aircraft** Statement by the operator as to whether the aircraft and LRNS combinations belong to a group or aircraft or not		
C	**Airworthiness documents showing aircraft eligibility for RNP 10.** AFM, AFM revision, AFM supplement, or Type certificate data sheet (TCDS) showing LRNS eligibility for RNP 10.		
D	**Aircraft modified to meet RNP 10 standards. Documentation on aircraft inspection and/or modification, if applicable.** Maintenance records documenting the installation or modification of LRNS and of the aircraft (*e.g.,* FAA Form 337 – major repairs and alterations).		
E	**For aircraft equipped only with INS or IRU: RNP 10 time limit and area of operations.** Documentation showing RNP 10 time limit and the area of operation or routes for which the navigation system/aircraft is eligible. (Not applicable for aircraft equipped with GNSS.)		
F	**Maintenance programme** • For aircraft with established LRNS maintenance practices, the list of references of the document or programme. • For recently installed LRNS, the maintenance practices for review.		
G	**Minimum equipment list (MEL) (only for operators conducting**		

Annex	Title of Annex/document	Indication of inclusion by the operator	Comments by the Inspector
	operations based on a MEL): MEL showing LRNS provisions.		
H	**Training** **1. LAR 91 operators or equivalent: Training method:** Training at home, LAR 142 training centres, or other training courses, course completion records. **2. LAR 121 and/or 135 operators or equivalent:** Training programmes (training curricula) for flight crews, flight dispatchers, and maintenance personnel.		
I	**Operating policies and procedures** **1. LAR 91 operators or equivalent:** Operations manual (OM) or sections to be attached to the application, corresponding to RNP 10 operating procedures and policies. **2. LAR 121 and/or 135 operators or equivalents:** Operations manual and checklists.		
J	**Past performance.** If any, previous problems, incidents, path-keeping errors, corrective action will be included.		
K	**Withdrawal of RNP 10 approval** Indication of the need to follow up on navigation error reports submitted and the possibility of withdrawal of RNP 10 approval.		
	Validation flight plan: Only if required by the CAA.		

CONTENTS OF THE APPLICATION TO BE SUBMITTED BY THE OPERATOR

____ **RNP 10 COMPLIANCE DOCUMENTATION OF THE AIRCRAFT/NAVIGATION SYSTEMS**

____ **OPERATING PROCEDURES AND POLICIES**

____ **SECTIONS OF THE MAINTENANCE MANUAL RELATED TO LRNS (if not previously reviewed)**

Note 1: Documents may be grouped in a single binder or may be submitted as individual documents.

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PART 4: CONTENTS OF OPERATOR APPLICATION FOR RNP 10

#	Contents of the RNP 10 application by the operator	Reference paragraphs CA 91-001	In what Annexes/Documents of the operator can the application contents be located Note: The operator must update this column to reflect the contents of the application	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
1	**Operator request letter** Statement of intent to obtain RNP 10 authorization.	Paragraph 9.1.1 b) 1) Appendix 2, Paragraph e)	Annex A		
2	**Aircraft/ navigation system RNP 10 eligibility method** Airworthiness documents that establish the aircraft/navigation system eligibility method, its approval status, and, in a format acceptable to the inspector, a list of airframes included in this method.	Paragraphs 8.2 and 8.3	Annex B Annex C		
2a	**Dual LRNS requirement** At least two LRNS with displays and functions suitable for oceanic operations are required.	Paragraph 8.1.1 Paragraph 10.2	Annex B Annex C		
3	**Time limit only for aircraft equipped with INS or IRU** RNP 10 time limit proposed or approved for	Paragraph 8.4	Annex B Annex C		

#	Contents of the RNP 10 application by the operator	Reference paragraphs CA 91-001	In what Annexes/Documents of the operator can the application contents be located Note: The operator must update this column to reflect the contents of the application	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
	aircraft with INS or IRU as the only source of long-range navigation (LRN). (Not applicable for aircraft equipped with GNSS.)				
4	**RNP 10 area of operation for aircraft equipped only with INS and IRU.** Documentation establishing the area of operation or RNP 10 routes for which the navigation system/aircraft is eligible. (Not applicable for aircraft equipped with GNSS.)	Paragraphs 10.5 and 10.9 (Paragraphs 10.10 and 10.11, as applicable)			
5	**Training** **1. LAR 91 operators or equivalent: Training methods:** The following methods are acceptable for these operators: Training at home, LAR 142 training centres, or other training courses. **2. LAR 121 or 135 operators or equivalent: Training programmes:** Operators will develop an initial and periodic training programme for flight crews, flight dispatchers, if applicable, and maintenance personnel.	Paragraph 12 b) Paragraph 12 a)	Annex F		

#	Contents of the RNP 10 application by the operator	Reference paragraphs CA 91-001	In what Annexes/Documents of the operator can the application contents be located Note: The operator must update this column to reflect the contents of the application	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
6	**Operating policies and procedures** 1. **LAR 91 operators or equivalent:** Operations manual or section of the operator application documenting RNP 10 policies and procedures. 2. **LAR 121 and/or 135 operators or equivalent:** Operations manual and checklists.	 Paragraph 9.1.1 b) 6) (b) Paragraph 9.1.1 b) 6) (a)	Annex G		
7	**Maintenance practices** • For aircraft with established LRNS maintenance practices, the operator will provide document references. • For newly installed LRNS systems, the operator will provide maintenance practices for review.	Paragraph 8.5 b)	Annex D		
8	**Minimum equipment list (MEL) update** Applicable to operators conducting operations according to a MEL.	Paragraphs 8.5 a) and 9.1.1 b) 7)	Annex E		
9	**Past performance.** Performance record identifying previous problems, incidents,	Paragraph 9.1.1 b) 10)			

#	Contents of the RNP 10 application by the operator	Reference paragraphs CA 91-001	In what Annexes/Documents of the operator can the application contents be located Note: The operator must update this column to reflect the contents of the application	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
	track keeping errors and corrective actions.				
10	**Withdrawal of RNP 10 operating authority** Indication of the need for follow-up on the navigation error reports and the possibility of withdrawal of the RNP approval.	Paragraph 9. 3	Annex H		
11	**Validation flight plan, only if required** The validation flight plan will be presented only if required.	Paragraph 9.1.1 d)			

PART 5 – GUIDE FOR DETERMINING RNP 10 AIRCRAFT ELIGIBILITY

#	Topics	Reference paragraphs CA 91-001	Location in the Annexes of the operator	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
1	**Group aircraft definition**	Paragraph 8.2.1	Annex B		
2	**Dual long-range navigation system (LRNS)**	Paragraph 10.2	Annex B		
3	**Eligibility Method 1.-** Eligibility of aircraft through RNP certification (RNP compliance documented in the AFM).	Paragraph 8.3.1 a)	Annex B		
4	**Eligibility Method 2.-** Eligibility of aircraft through previous certification of the navigation system.	Paragraph 8.3.1 b)	Annex B		
4a	INSs or IRUs approved according to LAR 121, Appendix G (time limit 6.2 hours)	Paragraph 8.3.1 b) 4)	Annex B		
4b	INSs or IRUs approved for MNPS operations in the North Atlantic (time limit 6.2 hours)	Paragraph 8.3.1 b) 6)	Annex B		
4c	Obtaining of approval with extended time limit for aircraft equipped with INS or IRU systems.	Paragraph 8.4	Annex B		
4d	GNSS (*e.g.,* GPS) approved as primary means of navigation (AC 20-138 or equivalent)	Paragraph 8.3.1 b) 1)	Annex B		
4e	Multi-sensor systems into which the GNSS	Paragraph 8.3.1 b) 2)	Annex B		

#	Topics	Reference paragraphs CA 91-001	Location in the Annexes of the operator	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
	(*e.g.,* GPS) is integrated (AC 20-130 or equivalent)				
4f	Equipment with a single GNSS and another approved LRNS (*e.g.*, INS or IRU)	Paragraph 8.3.1 b) 7)	Annex B		
5	**Eligibility Method 3 – Eligibility through data collection**	Paragraph 8.3.1 c)	Annex B		
5a	Sequential method	Paragraph 8.3.1 c) 2) (a)	Annex B		
5b	Periodic method	Paragraph 8.3.1 c) 2) (b)	Annex B		

PART 6 - BASIC PILOT PROCEDURES FOR RNP 10 OPERATIONS

Topics		Reference paragraphs CA 91-001	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
Operating procedures		Paragraph 11	Annex G		
1	**Flight planning**	Paragraph 11.1 a)			
	Verifying if aircraft has been approved for RNP 10 operations	Paragraph 11.1 a) 1)			
	Verifying that two LRNS are operational	Paragraph 11.1 a) 2)			
	Verifying if the RNP 10 time limit has been taken into account (only aircraft equipped with INS or IRU)	Paragraph 11.1 a) 3)			
	Verifying the requirements for GNSS, such as FDE, if applicable to the operation	Paragraph 11.1 a) 4)			
	Verifying if the letter "R" has been inserted in Box 10 of the ICAO flight plan (also insert the letter Z in that same box, and NAV/RNP 10 in Box 18 for WATRS plus spaces)	Paragraph 11.1 a) 5)			
	If required, taking into account any operational restriction related to RNP 10 approval for a specific navigation system	Paragraph 11.1 a) 6)			

Topics		Reference paragraphs CA 91-001	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	Verifying the planned flight route, including the deviation to any alternate aerodrome, in order to identify the existing RNP types	Paragraph 11.1 a) 7)			
2	**Pre-flight procedures**	Paragraph 11.1 b)			
	Review flight technical records (maintenance logs) to ascertain the conditions of the equipment required for flight in RNP 10 airspace or route. Ensure that maintenance actions have been taken to correct defects in the required equipment	Paragraph 11.1 b) 1)			
	During the external inspection of the aircraft, check the condition of the navigation antennas and the condition of the fuselage skin around each of these antennas (this can be done by a competent and authorised person other than the pilot, like, for instance, an on-board mechanic or a maintenance person)	Paragraph 11.1 b) 2)			
	Review the emergency procedures for operations in RNP 10 airspace or routes. These are not different from the normal oceanic emergency procedures, with one exception: crews must	Paragraph 11.1 b) 3)			

Topics		Reference paragraphs CA 91-001	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	be capable of recognising, and the ATC must be notified, when the aircraft is no longer capable of flying at its capacity level according to the RNP 10 approval				
3	**En-route procedures**	Paragraph 11.1 c)			
	At the oceanic point of entry, at least two LRNS must be capable of navigating in RNP 10, otherwise, the crew will consider using an alternate route or initiating a deviation to repair the systems	Paragraph 11.1 c) 1)			
	Before entering oceanic airspace, aircraft position must be checked as accurately as possible using external navigation aids. This may require DME/DME or VOR checks to identify navigation system errors by comparing displayed and actual positions. If it is necessary to update the system, the appropriate procedures must be followed with the assistance of a prepared checklist	Paragraph 11.1 c) 2)			
	Operating procedures must include mandatory cross-check procedures in order to identify navigation errors in advance and	Paragraph 11.1 c) 3)			

Topics		Reference paragraphs CA 91-001	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	prevent the aircraft from inadvertently deviating from the routes authorised by the ATC				
	Crews must notify the ATC of any degradation or failure of the navigation equipment below the navigation performance requirements, or of any deviation required for a contingency procedure	Paragraph 11.1 c) 4)			
	Pilots must use a lateral deviation indicator, an FD or an AP in lateral navigation mode (LNAV) for RNP 10 operations. All pilots are expected to follow the route centreline, as represented on the on-board lateral deviation indicators and/or flight guidance, during all RNP 10 operations, unless authorised by the ATC to deviate or due to an emergency. For normal operations, the cross-track error/deviation (the difference between the path estimated by the RNP system and the position of the aircraft relative to the path) must be limited to ± ½ the navigation precision associated with the flight route (*e.g.*, 5 NM). Small lateral deviations from this requirement are allowed (*e.g.*,	Paragraph 11.1 c) 5)			

	Topics	Reference paragraphs CA 91-001	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	overshooting or undershooting the path) during or immediately after an en-route turn, up to a maximum of 1 times (1xRNP) the navigation precision (*e.g.*, 10 NM). ***Note.-*** *Some aircraft do not show or do not estimate a path during turns. Pilots of such aircraft may not be capable of meeting the ± ½ precision requirement during en-route turns; however, they are expected to meet interception requirements after the turn or in the straight segments.*				
4	**Update the LRNS position**				
	Impact of en-route updates	Paragraph 10.9			
	Update the automatic position (as applicable).	Paragraph 10.10			

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PART 7 - PROCEDURES FOR IN-FLIGHT CONTINGENCIES, DEVIATIONS DUE TO WEATHER CONDITIONS AND STRATEGIC LATERAL DISPLACEMENT

Topics		**CA 91-001** **Reference paragraphs** Doc 4444, Paragraph 15.2	**Location in the Annexes of the operator**	**Comments and/or recommendations by the CAA**	**Follow-up by the Inspector: Item status and date**
Procedures			Annex G		
1	**Special procedures for in-flight contingencies in oceanic airspace**	CA 91-001, Paragraph 11.1 d) 2) (a) Doc 4444, Paragraph 15.2			
	Introduction	CA 91-001, Paragraph 11.1 d) 2) (a) (1) Doc 4444, Paragraph 15.2.1			
	General procedures	CA 91-001, Paragraph 11.1 d) 2) (a) (2) Doc 4444, Paragraph 15.2.2			
	Extended range operations by aeroplanes with two turbine power-units (ETOPS)	CA 91-001, Paragraph 11.1 d) 2) (a) (3) Doc 4444, Paragraph 15.2.2.4			
2	**Procedures for deviations due to weather conditions**	CA 91-001, Paragraph 11.1 d) 2) (b) Doc 4444, Paragraph 15.2.3			
	General aspects	CA 91-001, Paragraph 11.1 d) 2) (b) (1) Doc 4444, Paragraph 15.2.3.1			
	Measures to be taken when controller-pilot communications are established.	CA 91-001, Paragraph 11.1 d) 2) (b) (2) Doc 4444, Paragraph 15.2.3.2			
	Measures to be taken in order to obtain a revised ATC clearing.	CA 91-001, Paragraph 11.1 d) 2) (b) (3)			

	Topics	CA 91-001 Reference paragraphs Doc 4444, Paragraph 15.2	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
		Doc 4444, Paragraph 15.2.3.3			
3	**Procedures for strategic lateral displacement in oceanic airspace and remote continental areas.**	CA 91-001, Paragraph 11.1 d) 2) (c) Doc 4444, Paragraph 15.2.4			

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Job Aid RNAV 10 (designated and authorised as RNP 10)
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APPENDIX B-1

ADVISORY CIRCULAR

AC	**:**	**91-002**
DATE	**:**	**12/10/09**
REVISION	**:**	**1**
ISSUED BY	**:**	**SRVSOP**

SUBJECT: AIRCRAFT AND OPERATORS APPROVAL FOR RNAV 5 OPERATIONS

ADVISORY CIRCULAR

AC	**:**	**91-002**
DATE	**:**	**12/10/09**
REVISION	**:**	**1**
ISSUED BY	**:**	**SRVSOP**

SUBJECT: AIRCRAFT AND OPERATORS APPROVAL FOR RNAV 5 OPERATIONS

1. PURPOSE

This advisory circular (AC) provides acceptable means of compliance (AMC) concerning aircraft and operators approval for RNAV 5 operations.

An operator may use alternative means of compliance, as far as those means are acceptable for their respective Civil Aviation Authority (CAA).

The use of the verb in future or the word "must", is applied to an applicant or operator choosing to fulfill the criteria described in this AC.

This AC also provides guidelines to operators when the stand-alone global positioning system (GPS) is used as the means of navigation in RNAV 5 operations (where the stand-alone GPS equipment provides the only RNAV capability installed on board the aircraft).

2. LATIN AMERICAN AERONAUTICAL REGULATIONS (LAR) RELATED SECTIONS OR EQUIVALENT REGULATIONS

LAR 91: Sections 91.1015 and 91.1640 or equivalents

LAR 121: Section 121.995 (b) or equivalent

LAR 135: Section 135.565 (c) or equivalent

3. RELATED DOCUMENTS

ICAO Doc 9613	Performance-based navigation (PBN) manual and its related documentation
EASA AMC 20-4	Airworthiness approval and operational criteria for the use of navigation systems in European airspace designated for Basic RNAV operations and its related documentation
FAA AC 90-96A	Approval of U.S. operators and aircraft to operate under instrument flight rules (IFR) in European airspace designated for basic area navigation (B-RNAV) and precision area navigation (P-RNAV) and its related documentation
Spain DGAC CO 1/98	Resolution for operational approval and criteria for the use of navigation systems in European airspace designated for Basic RNAV operations

4. DEFINITIONS AND ABREVIATIONS

4.1 Definitions

a) **Area navigation (RNAV)**.- A method of navigation which permits aircraft operation on any desired flight path within the coverage of ground or space-based navigation aids or within the limits of the capability of self-contained aids, or a combination of these.

***Note.-** Area navigation includes performance-based navigation as well as other operations that do not meet the definition of performance-based navigation.*

b) **Area navigation route**.- An Air traffic services (ATS) route established for the use of aircraft capable of employing area navigation.

c) **Global positioning system (GPS)**.- The United States Global navigation Satellite System (GNSS) is a satellite-based radio navigation system which utilizes precise range measurements to determine position, velocity and time in anywhere in the world. The GPS is composed by three elements: space, control, and user. The space element is formed of at least 24 satellites in 6 orbital planes. The control element consists of 5 monitor stations, 3 ground antennas, and a master control station. The user element consists of antennas and receivers that provide positioning, velocity and precise timing to the user.

d) **Navigation specifications**.- A set of aircraft and air crew requirements, needed to support performance based navigation operations within a defined airspace. There are two kinds of navigation specifications: RNAV and RNP. A RNAV specification does not include requirements for on-board performance monitoring and alerting. A RNP specification includes requirements for on-board performance monitoring and alerting.

e) **Performance based navigation (PBN)**.- Area navigation based on performance requirements for aircraft operating along an ATS route, on an instrument approach procedure or in a designated airspace.

***Note.-** Performance requirements are expressed in navigation specifications (RNAV specification, RNP specification) in terms of accuracy, integrity, continuity, availability and functionality needed for the proposed operation in the context of a particular airspace concept.*

f) **Receiver autonomous integrity monitoring (RAIM)**.- A technique used within a GPS receiver/processor to determine the integrity of its navigation signals using only GPS signals, or GPS signals augmented with barometrical altitude data. This determination is achieved by a consistency check among redundant pseudo-orange measurements. At least one additional satellite needs to be available in respect to the number of satellites that are needed to obtain the navigation solution.

g) **RNAV operations**.- Aircraft operations using area navigation for RNAV applications. RNAV operations include the use of area navigation for operations which are not developed in accordance with the PBN manual.

h) **RNAV system**.- Area navigation system, which permits aircraft operation on any desired flight path within the coverage of ground or space-based navigation aids, or within the limits of the capability of self-contained aids, or a combination of both. A RNAV system may be included as part of the Flight Management System (FMS)

4.2 Abreviaturas

a) AC Advisory circular (FAA)

b) ADF Automatic direction finder

c) AFM Aircraft flight manual

d) AIP Aeronautical information publication

e) AIRAC Aeronautical information regulation and control

f) AMC Aceptable means of compliance

g) ANSP Air navigation services provider

h) ATC Air traffic control

i)	ATS	Air traffic services
j)	B-RNAV	Basic area navigation
k)	CA	Advisory circular (in spanish - SRVSOP)
l)	CAA	Civil Aviation Authority
m)	CDI	Course deviation indicator
n)	CDU	Control display unit
o)	CO	Operational Circular (Spain)
p)	DME	Distance measuring equiment
q)	DOP	Dilution of precision
r)	EASA	European Aviation Safety Agency
s)	ETSO	EASA Technical standard order
t)	EUROCAE	European organization for civil aviation equipment
u)	FAA	Federal Aviation Administration (United States)
v)	FDE	Fault detection and exclusion
w)	FMS	Flight management system
x)	FTE	Flight technical error
y)	GNSS	Global navigation satellite system
z)	GPS	Global positioning system
aa)	HSI	Horizontal situation indicator
bb)	IFR	Instrument flight rules
cc)	INS	Inertial navigation system
dd)	IRS	Inertial referente system
ee)	IRU	Inertial referente unit
ff)	LAR	Latin American Aeronautical Regulations
gg)	LOA	Letter of authorization/Letter of acceptance
hh)	MEL	Minimum equipment list
ii)	NAVAIDS	Navigation aids
jj)	NDB	Non-directional beacon
kk)	ND	Navigation display
ll)	NOTAM	Notice to airmen
mm)	ICAO	Internacional Civil Aviation Orgatization
nn)	OM	Operations manual
oo)	PBN	Performance based navigation
pp)	PF	Pilot flying
qq)	PNF	Pilot not flying
rr)	POH	Pilot operating handboock
ss)	RAIM	Receiver autonomous integrity monitoring

tt) P-RNAV Precision area navigation

uu) RAIM Receiver autonomous integrity monitoring

vv) RNAV Area navigation

ww) RTCA Radio technical commission for aeronautics

xx) SA Selective availability

yy) SB Service bulletin

zz) STC Supplemental type certificate

aaa) TCDS Type certificate data sheet

bbb) TLS Target level of safety

ccc) TSO Technical standard order

ddd) VOR Very hight frecuency (VHF) omni-directional radio range

eee) WGS World geodetic system

fff) WPT Waypoint

5. INTRODUCTION

5.1 In January 1998, the European Air Safety Agency (EASA) published the document related to the acceptable means of compliance (AMC 20-4) which replaced the Temporary guidance Leaflet No. 2 (TGL No. 2) issued by former JAA. This AMC contains acceptable means of compliance related to airworthiness approval and operational criteria for the use of navigation systems in European air space designated for basic area navigation operations (Basic RNAV or B-RNAV).

5.2 In the same manner, the Federal Aviation Administration (FAA) of the United States (U.S.) replaced the AC 90-96 of March 1998 by AC 90-96A issued in January 2005. This new circular provides guidance material in regards to the airworthiness and operational approval for operators of U.S. registered civil aircraft operating in European air space designated for Basic area navigation (B-RNAV) and Precision area navigation (P-RNAV).

5.3 Both current documents, AMC 20-4 and AC 90-96A, require similar operational and functional requirements.

5.4 In the context of the terminology adopted in the Performance based navigation manual (PBN manual) of the International Civil Aviation Organization (ICAO), B-RNAV requirements are termed RNAV 5.

5.5 The basis of specifications developed by EASA and FAA are supported on the capacity of RNAV equipments incorporated in the early 70s.

5.6 While RNAV operation requirements are addressed primarily in an ATS surveillance environment, RNAV 5 implementation has occurred in areas where there is no surveillance. This has required an increase in route spacing to ensure compliance with the desired level of safety (TLS).

5.7 RNAV 5 specification does not require an alert to the pilot in the event of excessive navigation errors, neither requires two RNAV Systems, thus, the potential for loss of RNAV capability requires the aircraft to be provided of an alternative navigation source.

5.8 The performance level selected for RNAV operations allows a wide range of RNAV systems to be approved for these operations, including INS with a two hour limit after its last alignment/position update performed on the ground, when they do not have a function for automatic radio updating of aircraft position.

5.9 Although RNAV 5 specification does not include requirements for on-board performance monitoring and alerting, it does require that the on-board equipment keeps a lateral and longitudinal navigation accuracy on route of ± 5 NM or better during 95% of the total flight time.

6. GENERAL CONSIDERATIONS

6.1 Navaid infrastructure

a) The CAA may prescribe RNAV 5 navigation specification for specific routes or for specific areas or flight levels of an airspace.

b) RNAV 5 systems permit aircraft navigation along any desired flight path within the coverage of ground or space-base navigation aids (NAVAIDS) or within the limits of the capability of self-contained aids or a combination of both methods.

c) RNAV 5 operations are based on the use of RNAV equipment which automatically determines the aircraft position in the horizontal plane using input from one sensor or a combination of the following types of position sensors, together with the means to establish and follow a desired path:

1) VOR/DME;

2) ME/DME;

3) INS or IRS; and

4) GNSS.

Note.- *the application of the sensors is subject to the limitations contained in this AC.*

d) The Air navigation services providers (ANSP) must assess the NAVAID infrastructure in order to ensure that it is sufficient for the proposed operations, including reversionary modes.

e) It is acceptable for gaps in NAVAIDS coverage to be present; when this occurs, route spacing and obstacle clearance surfaces must be consider due to the expected increase in lateral track-keeping errors during the “dead reckoning” phase of flight.

6.2 Communication and air traffic services (ATS) surveillance

a) Direct pilot to ATC voice communication is required.

b) When reliance is placed on the use of ATS surveillance to assist contingency procedures, its performance should be adequate for that purpose.

c) Radar monitoring by the ATS may be used to mitigate the risk of gross navigation errors, provided the route lies within the ATS surveillance and communications service volumes and the ATS resources are sufficient for the task.

6.3 Obstacle clearance and route spacing

a) Detailed guidance on obstacle clearance is provided in PANS-OPS (Doc 8168), Volume II; the general criteria in Parts I and III apply.

b) The ANSP is responsible for route spacing and should have ATS surveillance and monitoring tools to support detection and correction of navigation errors.

c) In an ATC surveillance environment, the route spacing will depend on acceptable ATC workload and availability of controller tools.

d) The route design should account for the navigation performance achievable using the available NAVAID infrastructure, as well as the functional capabilities required by this document. Two aspects are of particular importance:

1) **Spacing between routes in turns**

(a) Automatic leg sequencing and associated turn anticipation is only a recommended function for RNAV 5. The track followed in executing turns depends upon the true airspeed, applied bank angle limits and wind. These factors, together with the different turn initiation criteria used by manufacturers, result in a large spread of turn performance. Studies have shown that for a track change of as little as 20 degrees, the actual path flown can vary by as much as 2 NM. This variability of turn performance must be considered in the design of the route structure where closely spaced routes are proposed.

2) **Along track distance between leg changes**

(a) A turn can start as early as 20 NM before the waypoint in the case of a large track angle change. Manually initiated turns may overshoot the following track.

(b) The track structure design has to ensure leg changes do not occur too closely together. The required track length between turns shall depend upon the required turn angle.

6.4 **Publication**

a) The AIP shall clearly indicate the navigation application is RNAV 5. The requirement for the carriage of RNAV 5 equipment in specific airspace or on identified routes should be published in the AIP.

b) The route must rely on normal descent profiles and identify minimum segment altitude requirements.

c) The navigation data published in the AIP for the routes and supporting navigation aids must meet the requirements of Chicago Convention Annex 15 - Aeronautical Information Services.

d) All routes must be based upon WGS-84 coordinates.

e) The available NAVAID infrastructure must be clearly designated on all appropriate charts (e.g. GNSS, DME/DME, VOR/DME). Any navigation facilities that are critical to RNAV 5 operations shall be identified in the relevant publications.

f) A navigation database does not form part of the required functionality of RNAV 5. The absence of such a database necessitates manual waypoint entry, which significantly increases the potential for waypoint errors. En-route charts should support gross error checking by the flight crew by publishing fix data for selected waypoints on RNAV 5 routes.

6.5 **Additional considerations**

a) Many aircraft have the capability to fly a path parallel to, but offset left or right from, the original active route. The purpose of this function is to enable offsets for tactical operations authorized by ATC.

b) In the same way, many aircraft have the capability to execute a holding pattern manoeuvre using their RNAV system; this capability can provide flexibility to ATC in designing RNAV 5 operations.

7. AIRWORTHINESS AND OPERATIONAL APPROVAL

7.1 In order to the operator receives an RNAV 5 authorization, this must comply with two types of approval:

a) Airworthiness approval in charge of the State of registry; (See Art. 31, Chicago Convention, Paragraph 5.2.3 and 8.1.1 of Annex 6, Part I; and

b) Operational approval required by the State of the operator (See Paragraph 4.2.1 and Attachment F of Annex 6 Part I).

7.2 For general aviation operators, the State of registration (See Paragraph 2.5.2.2 of Annex 6 Part II) will submit a Letter of Appointment (LOA) once determined that the aircraft accomplishes all applicable requirements of this document for RNAV 5 operations.

7.3 Compliance with airworthiness requirements by themselves does not constitute the operational approval.

8. AIRWORTHINESS APPROVAL

8.1 Aircraft equipment

a) An aircraft may be considered eligible for an RNAV 5 approval if it is equipped with one or more navigation systems approved and installed in accordance with the guide included in this document.

b) An aircraft capacity to perform RNAV 5 operations can be demonstrated or reached in the following cases

1) First case: Demonstrated capacity in the manufacturing process and declared in the Aircraft flight manual (AFM) or in the AFM supplement or in the Type certificate data sheet (TCDS) or in the Pilot operating handbook (POH).

2) Second case: Capacity reached in-service:

(a) By applying the service bulletin or supplemental type certificate or service letter or equivalent document and inclusion of the supplement in the AFM; or

(b) through aircraft navigation system approval.

8.2 Eligibility based on AFM or AFM supplement or TCDS or POH. To determine eligibility of the aircraft in function of AFM or AFM supplement, TCDS or POH, aircraft RNAV 5 capacity must have been demonstrated in production (aircraft in manufacturing process or new construction).

a) **Aircraft RNAV 5 systems eligibility.**

1) An aircraft may be considered eligible for RNAV 5 operations, if AFM or AFM supplement or TCDS or POH shows the appropriate instruments flight rules (IFR) navigation system installation has received airworthiness approval in accordance with this AC or AMC 20-4 or with one of the following FAA documents:

(a) AC 90-96, AC 90-45A, AC 20-121A, AC 20-130, AC 20-138 o AC 25-15

2) Airworthiness approval guidance included in this AC provides aircraft navigation performance equivalent to EASA AMC 20-4 and FAA AC 90-96A.

3) Once aircraft eligibility has been established, operator approval will proceed, according to paragraph 9 of this AC.

b) **LAR 91 aircraft approval**

1) LAR 91 operators should revise the AFM or AFM supplement or TCDS or POH to assure that the aircraft navigation system is eligible to perform RNAV 5 operations, according to describe on paragraph 8.2 a) 1) of this AC.

2) After having determined eligibility of the navigation system, LAR 91 operators will present respective documents to the AAC.

3) In case LAR 91 operators are not able to determine, based on the AFM or AFM supplement or TCDS or POH, whether the Aircraft system has been installed and approved according with an appropriate CA or AC or AMC, they will proceed according to paragraph 8.3. of this document.

c) **LAR 121 and/or 135 aircraft approval**

1) LAR 121 and/or 135 operators will present the following documents to AAC:

(a) Sections of the AFM or AFM supplement or TCDS that document airworthiness approval in accordance with this AC or with guidance materials mentioned in Paragraph 8.2 a) 1) of the this document.

2) These operators will ensure that the aircraft navigation system will meet the functions required in paragraph 8.6 of this CA.

3) In case a LAR 121 and/ or 135 operator is not able to determine, based on the AFM or AFM supplement or TCDS, whether the system has been installed and approved according to an appropriate CA or AC or AMC, it will proceed in accordance with to the steps established in the following paragraph.

8.3 Eligibility not based on AFM or TCDS or AFM Supplement or POH – RNAV 5 capacity reached during service.

a) *Determination of the aircraft eligibility through evaluation of its navigation equipment.*

1) The operator makes a request for assessment of aircraft RNAV equipment for eligibility to the airworthiness inspection Direction or equivalent CAA entity. The operator, together with the request, will provide the following:

(a) RNAV system make, model and part number;

(b) evidence that the equipment meets lateral and longitudinal navigation accuracy on route of ± 5 NM or better during 95% of the total flight time. This can be determined through the evaluation of system design. Evidence of meeting the requirements of another AC can be used for this purpose.

(c) proof that the system meets the required functions for RNAV 5 operations described in this CA on paragraph 8.6.

(d) crew operating procedures and bulletins; and

(e) any other pertinent information required by the CAA.

2) in case the airworthiness inspection Direction or CAA equivalent entity is not able to determine RNAV equipment eligibility, evaluation request together with supporting documents will be forward to the aircraft certification Direction or equivalent entity from the State of registry. In any case, aircraft certification Division or equivalent will inform to airworthiness inspection Direction or CAA equivalent entity about the eligibility of the proposed equipment to perform RNAV 5 operations.

3) *LAR 91 Operators*.- Once the CAA has determined the aircraft equipment is eligible for RNAV 5 operations, the airworthiness inspection Direction or CAA equivalent entity will issue a letter of finding documenting that the aircraft RNAV equipment is eligible to perform those operations.

4) *LAR 121 or 135 operators*.- The CAA will verify aircraft RNAV system eligibility including the required functions on paragraph 8.6 of this AC.

8.4 Limitations on the design and/or use of navigation systems.- Although the following navigation systems offer RNAV capability, these present limitations for their use in RNAV 5 operations.

a) **Inertial navigation systems/Inertial reference systems (INS/IRS)**

1) Inertial systems may be used either as a stand alone inertial navigation system (INS) or as an inertial reference (IRS) acting as part of a multi-sensor RNAV system where inertial sensors provides augmentation to the basic position sensors as well as a reversionary position data source when out of cover of radio navigation sources.

2) INS without a function for automatic radio updating of aircraft position and approved in accordance with FAA AC 25-4, when complying with the functional criteria of paragraph 8.6 of this AC, may be used only for a maximum of two (2) hours from the last alignment/position update performed on ground. Consideration may be given to specific

INS configurations (e.g. triple mix) where either equipment or aircraft manufacturer's data justifies extended use from the last position update.

3) INS without automatic radio updating of aircraft position, including those systems where manual selection of radio channels is performed in accordance with flight crew procedures, must be approved n accordance with FAA AC 90-45A or AC 20-130A or any other equivalent document.

b) **VHF omni-directional radio range (VOR)**

1) VOR accuracy can typically meet accuracy requirements for RNAV 5 up to 60 NM from the navigation aid and Doppler VOR up to 75 NM. Specific regions within the VOR coverage may experience larger due to propagation effect (e.g. multipath). Where such errors exist this can be accommodated by prescribing areas where the affected VOR may not be used.

c) **Distance measuring equiment (DME)**

1) DME signals are considered sufficient to meet requirements of RNAV 5 wherever the signals are received and there is no closer DME on the same channel, regardless of the published coverage volume. Where the RNAV 5 system does not take account of published "Designated operational coverage" of the DME, the RNAV system must execute data integrity checks to confirm that the correct DME signal is being received.

d) **Global navigation satellite system (GNSS)**

1) **Global positioning system (GPS)**

(a) The use of GPS to perform RNAV 5 operations is limited to equipment approved in accordance with the TSO-C 129(), TSO-C-145() and TSO-C-146() from FAA or ETSO-129(), ETSO-145() and ETSO-146() from EASA or equivalent documents which include the minimum systems functions specified in the present CA on Paragraph 8.6.

(b) The integrity of GPS system must be provided by the receiver autonomous integrity monitoring (RAIM) or an equivalent means within a multi-sensor navigation system. The equipment must be approved in accordance with the AMC 20-5 or equivalent document. In addition, stand-alone GPS equipment must include the following functions according to the TSO-C 129a or ETSO-129a criteria:

- Pseudorange step detection; and
- Health word checking

(c) Compliance with these two requirements can be determined the following way:

(1) a statement in the AFM or POH indicating the GPS equipment meets the criteria for primary means of navigation in oceanic and remote airspace; or

(2) a placard on the GPS receiver certifying it meets TSO-C 129 (), TSO-C-145 () and TSO-C-146 () from FAA or ETSO-129 (), ESTO-145 () and ESTO-146 () from EASA; or

(3) a CAA letter of design approval for the applicable equipment. Operators should contact the avionic equipment's manufacturer to determine if the equipment complies with these requirements and ask if a letter of design approval is available. Manufacturers may obtain this letter by submitting appropriate documentation to the certifications offices of the States of aircraft design or manufacturer. Operators will keep the letter of design approval within the AFM or POH as evidence of the RNAV 5 eligibility. Any limitations included in the letter of design approval should be reflected in a letter of finding to LAR 91 operators or in the operations specifications

(OpSpecs) for LAR 121 and/or 135 operators.

(d) Traditional navigation equipment (e.g., VOR, DME or automatic direction finder (ADF)) must be installed and operative, so as to provide an alternative navigation means of navigation.

(e) Where approval for RNAV 5 requires the use of traditional navigation equipment as a back up in the event of loss of GPS, the required navigation aids as defined in the approval (e.g. VOR, DME or ADF) must be installed and serviceable.

2) **Stand-alone GPS equipment**

(a) Stand-alone GPS equipment approved in accordance with guidance provided in this AC may be used in RNAV 5 operations, subject to the limitations included in this document. Such equipment must be operated in accordance with procedures acceptable to the CAA. The flight crew must receive appropriate training for use the stand-alone GPS equipment regarding normal and contingency procedures detailed in the Paragraph 10 of this AC.

8.5 RNAV-5 system requirements

a) Accuracy

1) The navigation performance of aircraft approved for RNAV 5 requires a track keeping accuracy equal to or better than ± 5 NM during the 95% of the flight time. This value includes signal source error, airborne receiver error, display system error and flight technical error (FTE).

2) This navigation performance assumes the necessary coverage provided by satellite or ground based navigation aids is available for the intended route to be flown.

b) Availability and integrity

The minimum level of availability and integrity required for RNAV 5 systems can be met by a single installed system comprising by:

1) one sensor or a combination of the following sensors: VOR/DME, DME/DME, INS or IRS and GNSS or GPS;

2) RNAV computer;

3) control display unit (CDU); and

4) navigation display(s) [(e.g. navigation display (ND), horizontal situation indicator (HSI) or course indicator deviation (CDI)]provided that the system is monitored by the flight crew and that in the event o a system failure the aircraft retains the capability to navigate relative to ground based navigation aids (e.g. VOR, DME or Non-directional beacon (NDB)).

8.6 Functional requirements

a) *Required Functions*.- The following system functions are the minimum required to conduct RNAV 5 operations:

1) Continuous indication of the aircraft position relative to track to be displayed to the pilot flying (PF) on a navigation display situated in his primary field of view;

2) In addition, where the minimum flight crew is two pilots, indication of the aircraft position relative to track to be displayed to the pilot not flying (PNF) on a navigation display situated in his primary field of view.

3) Display of distance and bearing to the active (To) waypoint;

4) Display of ground speed or time to active (To) waypoint;

5) Storage of a minimum of 4 waypoints; and

6) Appropriate failure indication of the RNAV system, including the sensors failure.

b) *RNAV 5 navigation displays*

1) Navigation data must be available for display either on a display forming part of the RNAV equipment or on a lateral deviation display (e.g. CDI, (E)HSI, or a navigation map display).

2) These displays must be used as primary flight instruments for the navigation of the aircraft, for maneuver anticipation and for failure/status/integrity indication. They should meet the following requirements:

(a) The displays must be visible to the pilot when looking forward along the flight path.

(b) The lateral deviation display scaling should be compatible with any alerting and annunciation limits, where implemented.

(c) The lateral deviation display must have a scaling and full-scale deflection suitable for the RNAV 5 operation.

8.7 Continued airworthiness

a) The operators of aircraft approved to perform RNAV 5 operations, must ensure the continuity of the technical capacity of them, in order to meet technical requirements established in this AC.

b) Each operator who applies for RNAV-5 operational approval shall submit to the CAA of State of registry, a maintenance and inspection program that includes all those requirements of maintenance necessary to ensure that navigation systems continue fulfilling the RNAV 5 approval criteria.

c) The following maintenance documents must be revised, as appropriate, to incorporate RNAV 5 aspects:

1) Maintenance control manual (MCM);

2) Illustrated parts catalogs (IPC); and

3) Maintenance program.

d) The approved maintenance program for the affected aircrafts should include maintenance practices listed in maintenance manuals of the aircraft manufacturer and its components, and must consider:

1) that equipment involved in the RNAV 5 operation should be maintained according to directions given by manufacturer's components;

2) that any amendment or change of navigation system affecting in any way RNAV 5 initial approval, must be forwarded and reviewed by the CAA for its acceptance or approval of such changes prior to its implementation; and

3) that any repair that is not included in the approved/accepted maintenance documentation, and that could affect the integrity of navigation performance, should be forwarded to the CAA for acceptance or approval thereof.

e) Within the RNAV maintenance documentation should be presented the training program of maintenance personnel, which inter alia, should include:

1) PBN concept;

2) RNAV 5 application;

3) equipment involved in a RNAV 5 operation; and

4) MEL use.

9. OPERATIONAL APPROVAL

9.1 *Requirements to obtain the operational approval*.- To obtain the operational approval, the operator will comply with the following steps considering the operational procedures established in Paragraph 10 of this AC.

a) *Airworthiness approval*.- The Aircraft must have the corresponding airworthiness approvals as mentioned in Paragraph 8 of this CA.

b) *Documentation*.- The operator will present to the AAC the following documents:

1) The application to obtain RNAV 5 authorization;

2) Amendments to the operations manual (OM) which must include operations procedures according to what is described in Paragraph 10 of this CA, for crews and dispatchers, if applicable;

3) Amendments, when applicable, of maintenance manuals and programs which must have the maintenance procedures for the new equipment, as well as the training of the maintenance associated personnel, in accordance with Paragraph 8.7 e);

4) A copy of the AFM parts, or AFM supplement or TCDS or POH, to verify the airworthiness approval for RNAV 5 for each affected aircraft;

5) The amendments to the Minimum Equipment List (MEL), which must identify the minimum necessary equipment to comply with RNAV 5; and

6) Training programs or amendments to the operator's training program for crews and flight dispatchers, if applicable, according to what is described in Paragraph 11 of this document;

c) *Training*.- Once the amendments to manuals, programs and documents have been accepted or approved, the operator will provide required training to its personnel.

d) *Validation flights*.- The AAC may perform a validation flight, if determines it is necessary in the interest of safety.

9.2 *Authorization issuance to perform RNAV 5 operations*.- Once the operator has successfully completed the operational approval process, the AAC will issue the operator, when applicable, the corresponding authorization to perform RNAV 5 operations.

a) *LAR 91 operators*.- For LAR 91 operators, the AAC does will issue a letter of authorization (LOA).

b) LAR 121 and/or 135 operators.- For LAR 121 and/or LAR 135 operators, the AAC will issue the corresponding OpSpecs, which will show RNAV 5 authorization.

10. OPERATION PROCEDURES

10.1 *Flight planning.*

a) Before operating on a RNAV 5 route, the operator will ensure that:

1) The aircraft counts on a RNAV 5 approval;

2) Routes correspond to the authorization;

3) The necessary equipment to operate RNAV 5 work correctly and are not degraded;

4) Navigation aids based on space or ground are available;

5) The crews check the contingency procedures.

b) *Stand-alone GPS equipment.* During the planning phase the following procedures must be accomplish in regards to the stand-alone GPS equipment:

1) An aircraft can depart without further action in the following cases, when:

(a) all satellites are scheduled to be in service; or

(b) one satellite is scheduled to be out of service in case of GPS equipment that includes barometrical altitude.

2) The availability of GPS integrity RAIM shall be confirmed for the intended flight (route and time) through the use of a prediction program either ground-based or incorporated in the on-board system, following the criteria established in Appendix 1 of the CAA, when:

(a) any satellite is scheduled to be out of service; or

(b) more than one satellite is scheduled to be out of service in case of GPS equipment that includes barometric altitude.

3) This prediction is required for any route and route segment RNAV 5 based upon the use of GPS.

4) The specified route of flight, including trajectory to any alternative aerodrome will be defined by a series of waypoints and by the estimated time of pass over them for a speed or series of speed, which at the same time will be in function of the intensity and previous wind direction.

5) Taking in consideration that during flight may occur deviations in regards to the specified ground speedy, prediction must be done using different speeds within the predictable margin for them.

6) Prediction program must be executed with a maximum anticipation of two hours preview to the flight departure. The operator will confirm that data about the state of the constellation and GPS ephemerides, have been updated with the latest information distributed by notice to airmen (NOTAM).

7) In order to get exact prediction, the program will allow manual de-selection of satellites considered non operative, as well as selection of those back to service condition during the flight time.

8) The operator will not dispatch or release a flight in case of continuous prediction loss of RAM higher than 5 minutes to any part of the previewed route. In this event, flight can be delayed, cancelled or re-routed in which RAM requirements may be accomplished.

c) *ATS – ICAO flight plan*.- At the time to file the ATS flight plan, authorized aircraft operators on RNAV 5 route, will insert corresponding code on flight plan form’s box 10 (equipment), as defined within ICAO Doc 7030 for these operations.

10.2 Preview flight procedures at the aircraft.- The crew will perform on the aircraft the following procedures preview to the flight:

a) check registrations and forms to be sure that maintenance actions have been taken in order to correct defects in the equipment; and

b) check data base validation (current AIRAC cycle), if it is installed.

10.3 *En route operations*.

a) The crew will assure the aircraft correct functioning of its navigation system during its operation in a RNAV 5 route, confirming that:

1) necessary RNAV 5 equipment have not degraded during flight;

2) route corresponds to the authorization;

3) aircraft navigation accuracy is pertinent for RNAV 5, assuring this through pertinent cross check; and

4) others navigation aids (for example VOR, DME y ADF) must be selected in a way to permit a cross check or immediate reversion in the event of a RNAV capacity loss.

10.4 *Contingency procedures*.

a) Flight crews must familiarize with the following general provisions:

1) An aircraft must not enter or continue the operations in airspace designated as RNAV 5, according to the present ATC authorization, if because of a failure or degradation the navigation systems falls under RNAV 5 requirements, the pilot will obtain as soon as possible an amended authorization;

2) According to ATC instructions, operations will continue in regards to the present ATC authorization, or when not possible, will be requested a revised authorization to return to the VOR/DME conventional navigation;

3) in the event of communications failure, the flight crew must continue with the flight plan, in accordance with the published lost communication procedures; and

4) in any case, the crew must follow contingency procedures established for every operation region, and obtain an ATC authorization as soon as possible.

b) Stand-alone GPS equipment.

1) The operating procedures must identify the flight crew actions required in the event of RAIM function loss or exceedance of integrity alarm limit (erroneous position). This procedures must include:

(a) In case of loss of the RAIM detection function.- The flight crew may continue navigating with the GPS equipment. The flight crew should attempt to cross-check the aircraft position with the information provided for the ICAO conventional navaids: VOR, DME and ADF, in order to confirm the existence of a required level of precision. In other case, the crew must revert to an alternative navigation means;

(b) In the event of an observed failure (including the failure of a satellite impacting the performance of the navigation systems based on GPS), the flight crew must revert to an alternative means of navigation.

(c) In case of exceedance of the alarm limit.- The flight crew must revert to an alternative means of navigation.

2) *On-board equipment availability VOR, DME or ADF*.- The operator must have installed on the aircraft the VOR, DME or ADF on-board equipment capacity according to the applied rules of operation LAR 91, 121 and 135. This capacity must be available along the intended route of flight to assure the availability of navigation alternative means in case of a GPS/RNAV system failure.

c) Any incidence registered in flight must be notified to the AAC in a maximum time of seventy two hours, unless justified cause.

11. NAVIGATION ERROR REPORTS FOLLOW UP PROCESS

a) The operator will establish a process to receive, analyze and do a follow up of the navigation error reports which allow determine the appropriate corrective action.

b) Repetitive navigation error occurrences, attributed to a specific part of the navigation equipment must be analyzed in order to correct its cause.

c) The nature and severity of the error may result in temporary withdrawn of the authorization to use the navigation equipment until the cause of the problem has been identified and rectified.

12. TRAINING PROGRAM

a) The training programs for flight crews and flight dispatchers, if correspond, must be reviewed and approved by the AAC. The operator will included at least the following modules:

1) Required equipments, capacities, limitations and operation of these equipments in RNAV 5 airspace.

2) The routes and airspace for which the RNAV system is approved to operate.

3) The NAVAID limitations in respect of the operation of the RNAV system to be used for the RNAV 5 operation.

4) Contingency procedures for RNAV failures.

5) The Radio/Telephony Phraseology for the airspace in accordance to Doc 4444 and Doc 7030 as appropriate.

6) The flight planning requirements for the RNAV operation.

7) RNAV requirements as determined from chart depiction and textual description.

8) RNAV 5 en route procedures;

9) Methods to reduce navigation errors through dead-reckoning techniques.

10) RNAV system-specific information, including:

   (a) Levels of automation, mode annunciations, changes, alerts, interactions, reversions, and degradation.

   (b) Functional integration with other aircraft systems.

   (c) Monitoring procedures for each phase of flight (for example, monitor PROG or LEGS page).

   (d) Types of navigation sensors (for example, DME, IRU, GNSS) utilized by the RNAV system and associated system prioritization/weighting/logic.

   (e) Turn anticipation with consideration to speed and altitude effects.

   (f) Interpretation of electronic displays and symbols.

11) RNAV equipment operating procedures, as applicable, including how to perform the following actions:

   (a) Verify currency of aircraft navigation data.

   (b) Verify successful completion of RNAV system self-tests.

   (c) Initialize RNAV system position.

   (d) Fly direct to a waypoint.

   (e) Intercept a course/track.

   (f) Be vectored off and rejoin a procedure.

   (g) Determine cross-track error/deviation.

   (h) Remove and reselect navigation sensor input.

   (i) When required, confirm exclusion of a specific navigation aid or navigation aid type.

   (j) Perform gross navigation error check using conventional navigation aids.

b) Training program on the GPS as a primary means of navigation.

   1) Besides the training modules describe on the previous paragraphs, operators' training programs which use RNAV systems based on GPS as a primary navigation means will include modules described in Appendix 2.

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Appendix 1

GPS integrity monitoring (RAIM) prediction program

Where a GPS integrity monitoring (RAIM) prediction program is used as a means of compliance with paragraph 5.2 (a) of this document, it should meet the following criteria:

a) The program should provide prediction of availability of the integrity monitoring (RAIM) function of the GPS equipment, suitable for conducting RNAV 5 operations in designated European airspace.

b) The prediction program software should be developed in accordance with at least RTCA DO 178B/EUROCAE 12B, Level D guidelines.

c) The program should use either a RAM algorithm identical to that used in the airborne equipment or an algorithm based on assumptions for RAIM prediction that give a ore conservative result.

d) The program should calculate AIM availability based on a satellite mask angle of no less than 5 degrees, except where use of lower mask angle has been demonstrated to be acceptable to the authority.

e) The program should have the capability to manually designate GPS satellites which have been notified as being out of service for the intended flight.

f) The program should allow the user to select:

   1) the intended route and declared alternates; and

   2) the time and duration of the intended flight.

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Appendix 2

Training program on the GPS as a primary means of navigation

The training programs for flight crews that use RNAV 5 systems based on the GPS as a primary means of navigation will include a segment with the following training modules:

a) GPS system components and operating principles.- Understanding of the GPS system and its operating principles:

   1) GPS system components: control segment, user segment, and space segment;
   2) on-board equipment requirements;
   3) GPS satellite signals and pseudo-random code;
   4) positioning principle;
   5) receiver clock error;
   6) masking function;
   7) performance limitations of the different types of equipment;
   8) WGS84 coordinate system;

b) Navigation system performance requirements.- Define the following terms in relation to the navigation system and evaluate the degree of compliance by the GPS system of the requirements associated with the following terms:

   1) precision;
   2) integrity;
      (a) means to improve GPS integrity: RAIM and fault detection and exclusion (FDE)
   3) availability;
   4) service continuity

c) Authorizations and documentation.- Requirements applicable to pilots and navigation equipment for GPS operation:

   1) pilot training requirements;
   2) aircraft equipment requirements;
   3) AFM system certification criteria and limitations;
   4) GPS-related NOTAMs.

d) GPS system errors and limitations.- Cause and magnitude of typical GPS errors:

   1) ephemerides;
   2) clock;
   3) receiver;
   4) atmospheric/ionospheric;
   5) multi-reflection;
   6) selective availability (SA);
   7) total typical error associated to the C/A code;
   8) effect of the dilution of precision (DOP) on the position;
   9) susceptibility to interference;

10) comparison of vertical and horizontal errors; and

11) path-tracking precision. Collision avoidance.

e) Human factors and GPS.- Limitations on the use of GPS equipment due to human factors. Operating procedures that offer protection against navigation errors and loss of awareness of the real situation due to the following causes:

1) mode errors;

2) data entry errors;

3) data checks and validation, including independent cross-checking procedures;

4) automation-induced relaxation;

5) lack of standardization of GPS equipment;

6) information processing by humans and situational awareness.

f) GPS equipment – Specific navigation procedures.- Knowledge of the appropriate operating procedures for GPS in the typical navigation tasks for each specific type of equipment in each type of aircraft that includes:

1) selection of the appropriate operating mode;

2) review of the different types of information contained in the navigation database;

3) forecast of the availability of the RAIM function;

4) procedure for entering and checking the waypoints defined by the user;

5) procedure for entering, retrieving and checking flight plan data;

6) interpretation of the typical information shown on the GPS navigation display: LAT/LONG, distance and heading to the waypoint, CDI;

7) interception and maintenance of the GPS-defined routes;

8) in-flight determination of ground speed (GS), estimated time of arrival (ETA), time and distance to the waypoint;

9) indication of waypoints over flight;

10) use of the "DIRECT TO" function;

11) use of the "NEAREST AIRPORT" function;

12) use of the GPS in GPS or DME/GPS arrival procedures.

g) Verification of GPS equipment.- For each type of equipment in each aircraft, the following operational and start-up checks must be conducted at the appropriate time:

1) constellation status;

2) RAIM and FDE functional status;

3) dilution of precision (DOP) status;

4) currency of the instrument flight rules (IFR) database;

5) receiver operating condition;

6) CDI sensitivity;

7) position indication.

h) GPS messages and warnings.- For each type of equipment in each aircraft, timely action must be recognized and taken in face of GPS messages and warnings, including the following:

1) loss of RAIM function;

2) 2D/3D navigation;

3) dead-reckoning navigation mode;

4) database not updated;

5) loss of the database;

6) GPS equipment failure;

7) barometric data entry failure;

8) power failure;

9) prolonged parallel displacement; and

10) satellite failure.

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Appendix 3

RNAV 5 approval process

a) The RNAV 5 approval process is comprised of two types of approvals: the airworthiness approval and the operational approval, even though, they have different requirements, both must be considered under one process only.

b) This process constitutes a well-arrange method, which is used by the CAA to ensure the applicants comply with the established requirements.

c) The approval process is conformed by the following phases:

1) Phase one: Pre-application
2) Phase two: Formal application
3) Phase three: Analysis of the documentation
4) Phase four: Demonstration and inspection
5) Phase five: Approval

d) *In Phase One - Pre-aplication*, the CAA holds a meeting with the operator (the pre-aplication meeting), in which the operator will be informed about all the requirements that he needs to comply during the approval process.

e) *In Phase Two - Formal application*, the operator submits the formal application with all applicable documents.

f) *In Phase Three - Analysis of the documentation*, the CAA reviews the submission and evaluates the navigation equipment in order to determine the method of approval (aircraft equipment eligibility). As a result of this evaluation the CAA may accept or return the Formal Application with the documentation.

g) *In Phase Four - Demonstration and inspection*, the operator will accomplish the training program and the validation flight if this is required by the CAA, otherwise the process will advance to the next phase.

h) *In phase Five - Approval*, the CAA issues the RNAV 5 authorization, once the operator has completed the airworthiness and operations requirements. For LAR 121 and/or 135 operators, the AAC will issue the OpSpecs and for LAR 91 operators will issue a LOA.

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APPENDIX B-2

RNAV 5 JOB AID

OPERATOR APPLICATION TO CONDUCT RNAV 5 OPERATIONS

RNAV 5 JOB AID

OPERATOR APPLICATION TO CONDUCT RNAV 5 OPERATIONS

1. Introduction

This job Aid was developed by the Regional Cooperation System for Safety Oversight (SRVSOP) to provide guidance to States, operators and inspectors on the process for operators to obtain an RNAV 5 authorization.

2. Purposes of this Job Aid

2.1 Provide RNAV 5 reference documents for operators and inspectors.
2.2 Provide a series of tables that show: the content of an application, related reference paragraphs, location in operator application where RNAV 5 elements are addressed and columns for the inspector to comment on, and track the status of various RNAV 5 elements.

3. Recommended inspector and operator actions

The following are suggestions on how the Job Aid can be used:

3.1 Inspector reviews the basic events in the RNAV 5 approval process in Part 1 with the operator in the pre-application meeting to provide an overview of approval process events.
3.2 Inspector reviews this Job Aid with the operator to establish the form and content of the operator application for RNAV 5 authority.
3.3 Operator uses the Job Aid as guide to assemble documents/exhibits for its application for RNAV 5.
3.4 Operator annotates Job Aid to show location of RNAV 5 program elements in the operator exhibits/documents.
3.5 Operator submits Job Aid and RNAV 5 operator application (exhibits/documents) to inspector
3.6 Inspector annotates Job Aid to show task or document “complete/satisfactory” or “open/further operator action required”.
3.7 Inspector informs the operator as soon as possible, when further operator action is required.
3.8 Operator provides inspector, when requested, with revised material.
3.9 The CAA issues the operations specifications (OpSpecs) or a letter of authorization (LOA) as applicable, to operator when required tasks and documents are completed.

4. Job Aid organization

5. Primary source of documents, information and contacts

For accessing to the Advisory Circular CA 91-002, enter to the ICAO/SAM Regional Office Webpage (www.lima.icao.int) under SRVSOP.

6. Primary documents of reference

Documents of reference	Subjects
ICAO Doc 9613	Performance based navigation manual
AMC 25-11	Electronic display system
AMC 20-5	Acceptable means of compliance for airworthiness approval and operational criteria for the use of the NAVSTAR Global positioning system (GPS)
AC 20-121A	Airworthiness approval of LORAN C for use en the U.S National Airspace System
AC 20-130()	Airworthiness approval of multi-sensor navigational system for use in the U.S. National Airspace System
AC 20-138A	Airworthiness approval of Global navigation satellite system (GNSS) equipment
AC 25-4	Inertial navigation system (INS)
AC 25-15	Approval of FMS in transport category airplanes
AC 90-45A	Approval of areas navigation systems for use in the U.S. National Airspace System
ETSO-C115b	Airborne area navigation equipment using multi sensor input
ETSO-C129A	Airborne supplemental navigation equipment using the Global positioning system (GPS)
ETSO-C145	Airborne navigation sensors using the Global positioning system (GPS) augmented by wide area augmentation system (WAAS)

ETSO-C146	Stand-alone airborne navigation equipment using the Global positioning system (GPS) augmented by the wide area augmentation system (WAAS)
TSO-C115, any version	Airborne area navigation equipment using multi-sensor inputs
TSO-C129/C129A	Airborne supplemental navigation equipment using the global positioning system (GPS)
TSO-C145A	Airborne navigation sensors using the Global positioning system (GPS) augmented by the wide area augmentation system (WAAS)
TSO-C146A	Stand-alone airborne navigation equipment using the Global positioning system (GPS) augmented by the wide area augmentation system (WAAS)
RTCA/DO-200A	Standards for processing aeronautical data
RTCA/DO-201A	Standards for aeronautical information
RTCA/DO-208	Minimum operational performance standards for airborne supplemental navigation equipment using Global positioning system (GPS)
RTCA/DO-229C	Minimum operational standards for Global positioning system/Wide area augmentation system airborne equipment
RTCA/DO-236A	Minimum aviation system performance standards: Required navigation performance for area navigation
RTCA/DO-178B	Software consideration in airborne systems and equipment certification

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PART 1: GENERAL INFORMATION

Basic events in RNAV 5 approval process

	Operator actions	CAA actions (inspectors)
1	Establishes the need to obtain the RNAV 5 authorization.	
2	Reviews AFM, AFM Supplement or Type Certificate Data Sheet (TCDS) or others appropriate documents (e.g., Service Bulletins, Service Letters) to determine Aircraft eligibility for RNAV 5. Operator contacts airplane or avionics manufacturer, if necessary, to confirm airplane eligibility for RNAV 5.	
3	Contacts to the AAC to arrange a pre-application meeting to discuss requirements for operational approval. .	
4		During pre-application meeting, establishes: • form and content of operator application; • the date when operator application should be submitted for evaluation
5	Submits operator application to the AAC at least 60 days in advance of the planned start of RNAV 5 operations.	
6		Reviews operator application
7	Once the amendments to the manuals, programs and documents have been accepted or approved, the operator provides training to the flight crew, flight dispatchers and maintenance personnel and performs a validation flight in case of that flight is required by the AAC.	
8		Issues operational approval in the form of OpSpecs for LAR 121 and/or 135 or a letter of authorization (LOA) for LAR 91 operators.

Notes related with the approval process

1. **Responsible Authority.**

   a. **Commercial Air Transport - LAR 121 and/or 135 or equivalent regulations operators.- The State of registry** makes the determination that the Aircraft meets the applicable RNAV 5 requirements. The State of operator issues operating authority (e.g., OpSpecs).

   b. **General aviation - LAR 91 or equivalent regulations operators.-** The **State of registry** makes determination that aircraft meets the applicable RNAV 5 requirements and issues a LOA.

2. Sections related to the Latin American Aeronautical Regulations (LAR) or equivalents.

   a. LAR 91 Section 91.1015 and 91.1640 or equivalents

   b. LAR 121 Section 121.995 (b) or equivalent

   c. LAR 135 Section 135.565 (c) or equivalent

3. Others related ICAO documents

   a. Annex 2 – Rules of the air

   b. Doc 4444 – Procedures for Air Navigation Services – Air Traffic Management.

PART 2: AIRCFRAT AND OPERATORS IDENTIFICATION INFORMATION

OPERATOR NAME: ____

Aircraft make, model and series	Registration number(s)	Serial number(s)	RNAV navigation systems: Number, manufacturer and model	Navigation specification requested

DATE OF PRE-APPLICATION MEEETING____

DATE APPLICATION RECEIVED:____

DATE OPERATOR PLANS TO START RNAV 5 OPERATIONS_____________________________________

¿IS THE NOTIFICATION TIME TO CAA ADEQUATE? YES _____ NO _____

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PART 3 – OPERATOR APLICATION (EXHIBITS/DOCUMENTS)

Exhibit	Document title	Operator indication of inclusion	Inspector comments
A	**Operator letter requesting RNAV 5 authorization**		
B	**1. For aircraft manufactured RNAV 5 compliant: Airworthiness documents that show RNAV 5 approval:** • AFM, AFM Supplement, TCDS o POH. **2. For in-service aircraft which eligibility can not be determined based on the AFM, AFM Supplement; TCDS o POH:** • Operator letter requesting assessment of aircraft RNAV equipment.		
C	**For INS or IRU only equipped aircraft: RNAV 5 time limit and area of operation.** • Documentation establishing the RNAV 5 time limit and area of operations or routes for which the specific aircraft/navigation system is eligible. (Not applicable to GPS equipped aircraft).		
D	**Maintenance program** • For aircraft with established RNAV 5 or GPS stand-alone maintenance practices, provide list of document or program references.		
E	**Minimum Equipment List (MEL) (Only for operators operating under an MEL):** • MEL showing provisions for RNAV 5 equipment or GPS stand-alone.		
F	**Training**		

Exhibit	Document title	Operator indication of inclusion	Inspector comments
	1. LAR 91 operators: Methods of training: The following methods are acceptable for these operators: In-house training, LAR 142 training center or others courses of training. **2. LAR 121 or 135 operators: Training program:** The LAR 121 or 135 operators shall provide initial and recurrent training program for flight crew, flight dispatchers and maintenance personnel. **3. GPS stand-alone:** When the operator used a GPS stand-alone to conduct RNAV 5 operations, shall provide an initial and a recurrent training program for flight crew, flight dispatchers and maintenance personnel, if required.		
G	**Operational policies and procedures** **1. LAR 91 operators:** Operations manual or sections of operator's application, documenting RNAV 5 operational policies and procedures. **2. LAR 121 and/or 135 operators:** Operations manual and check list. **3. GPS stand-alone used as a primary means of navigation:** Operations manual		
H	**Removal of RNAV 5 operating authority** Indication of the necessity to follow up action after navigation error reports, and the potential for removal of RNAV 5 operating authority.		
I	**Plan for validation flight:** Only if required by the CAA		

APLICATION CONTENT TO BE SUBMITED BY THE OPERATOR

____ **AIRCRAFT/RNAV 5 SYSTEM COMPLIANCE DOCUMENTATION**

____ **OPERATIONAL POLICY/PROCEDURES**

____ **MAINTENANCE MANUAL SECTIONS RELATED TO RNAV 5 SYSTEM OR GPS STAND-ALONE (if not previously reviewed)**

Note 1: Exhibits/documents may be included in a binder or submitted as a stand-alone documents

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PART 4: CONTENT OF OPERATOR APPLICATION FOR RNAV 5

#	Content of operator application for RNAV 5	Reference paragraphs CA 91-002	Where found in operator exhibit/documents Note: operator should update this column to reflect the content of its application	Inspector recommendation and /or comments	Inspector Tracking: Item status and date
1	**Operator request letter** Statement of intent to obtain RNAV 5 authorization	Paragraph 9.1 b) 1) Appendix 3, Paragraph e)	Exhibit A		
2	**Airworthiness documents to determine Aircraft eligibility** Airworthiness documents that establish the aircraft and the navigation system have been approved for RNAV 5 operations.	Paragraphs 8.1, 8.2 y 8.3	Exhibit B Exhibit C		
3	**RNAV 5 system requirements** Documents that show the aircraft equipment 1. One (1) RNAV system comprising of: • one or a combination of the following navigation sensors: VOR/DME, DME/DME, INS o IRS, LORAN C y GNSS o GPS; • an area navigation (RNAV) computer; • a control display unit (CDU);	Paragraph 8.5 b)	Exhibit B Exhibit C		

#	Content of operator application for RNAV 5	Reference paragraphs CA 91-002	Where found in operator exhibit/documents Note: operator should update this column to reflect the content of its application	Inspector recommendation and /or comments	Inspector Tracking: Item status and date
	and • a navigation display(s) or instrument(s) (e. g., navigation display (ND), heading situation indicator (HSI) o course deviation indicator (CDI).				
4	**Availability of the conventional navigation equipment on board the aircraft when the GPS stand-alone is used** Documents that show the availability of the conventional navigation equipment on board the aircraft when the GPS stand-alone is used When GPS stand-alone equipment is used, the traditional navigation equipment (e. g., VOR, DME, TACAN o ADF), must be installed and operational in the aircraft, so as to provide an alternative means of navigation.	Paragraph 8.4 e) 1) iv.	Exhibit B Exhibit C		
5	**Training** **1. LAR 91 operators: Methods of training:** The following methods are acceptable for these operators: In-house training, LAR	Paragraphs 9.1 b) 6), 9.1 c) Paragraph 11	Exhibit F		

#	Content of operator application for RNAV 5	Reference paragraphs CA 91-002	Where found in operator exhibit/documents Note: operator should update this column to reflect the content of its application	Inspector recommendation and /or comments	Inspector Tracking: Item status and date
	142 training center or others courses of training. **2. LAR 121 or 135 operators: Training program:** The LAR 121 or 135 operators shall develop an initial and recurrent training program for flight crew, flight dispatchers and maintenance personnel. **3. GPS stand-alone:** When the operator used a GPS stand-alone to conduct RNAV 5 operations, shall developed an initial and a recurrent training program for flight crew, flight dispatchers and maintenance personnel, if required.	Paragraph 8.4 e) 2)			
6	**Operational policies and procedures** **1. LAR 91 operators:** Operations manual or sections of operator´s application, documenting RNAV 5 operational policies and procedures. **2. LAR 121 and/or 135 operators:** Operations manual and check list. **3. GPS stand-alone used as a primary means of navigation:**	Paragraph 9.1 b) 2) Paragraph 10 Paragraph 10. b)	Exhibit G		

#	Content of operator application for RNAV 5	Reference paragraphs CA 91-002	Where found in operator exhibit/documents Note: operator should update this column to reflect the content of its application	Inspector recommendation and /or comments	Inspector Tracking: Item status and date
	Operations manual				
7	**Maintenance practices** • For Aircraft with established RNAV or GPS stand-alone maintenance practices, the operator shall provide document references. • For newly installed RNAV or GPS stand-alone, the operator shall provide maintenance practices for review.	Paragraph 9. b) 3)	Exhibit D		
8	**Minimum equipment list (MEL) updates, if applicable** Only applicable if operator conducts operations under an MEL	Paragraph 9. b) 5)	Exhibit E		
9	**Continued airworthiness**	Paragraph 8.7	Exhibit H		
10	**Removal of RNAV 5 operating authority** Indication of the necessity to follow up action after navigation error reports, and the potential for removal of RNAV 5 operating authority.	Paragraph 12	Exhibit H		

PART 5 – GUÍDE FOR DETERMINING AIRCRAFT ELIGIBILTY

#	Subjects	Reference paragraphs CA 91-002	Location in operator exhibits	CAA Recommendations and comments	Inspector tracking item status and date
1	RNAV system requirement	Paragraphs 5.7, 6.2, 8.1 a) y 8.5 b).	Exhibit B		
2	Aircraft eligibility 1. For aircraft manufactured RNAV 5 compliant 2. For in-service aircraft which eligibility can not be determined based on the AFM, AFM Supplement; TCDS o POH:	Paragraphs 8.2 Paragraph 8.3 a)	Exhibit B		
3	GPS stand-alone used as a primary means of navigation	Paragraph 8.4 e) 1) iii. (first paragraph)	Exhibit B		
4	Multi-sensor navigation system that incorporate GPS with integrity provided by RAIM or equivalent means	Paragraph 8.4 e) 1) ii.	Exhibit B		
5	GPS stand-alone with integrity provided by RAIM	Paragraph 10. b) 2.	Exhibit B		
6	GPS stand-alone that include the following functions: • Pseudorange step detection; and • Health word cheking	Paragraph 8.4 e) 1) ii.	Exhibit B		

#	Subjects	Reference paragraphs CA 91-002	Location in operator exhibits	CAA Recommendations and comments	Inspector tracking item status and date
7	Availability of conventional navigation equipments when GPS stand-alone is used	Paragraph 8.4 e) 1) iv.	Exhibit B		
8	Aircraft requirements: RNAV 5 navigation systems	Paragraph 8.4	Exhibit B		
9	RNAV 5 system requirement • Precision • Availability and integrity	Paragraph 8.5	Exhibit B		
10	RNAV 5 system functional requirements • Required functions • RNAV 5 navigation displays	Paragraph 8.6	Exhibit B		
11	Navigation data base	Paragraph 10. d)	Exhibit B		

PART 6 – BASIC PILOT PROCEDURES FOR RNAV 5 OPERATIONS

Subjects	Reference paragraphs CA 91-002	Locations in operator exhibit	CAA recommendations and/or comments	Inspector tracking: Item status and date
Operating procedures	Paragraph 10	Exhibit G		
Flight planning	Paragraph 10.1			
Verify aircraft is approved for RNAV operation	Paragraph 10.1 a) 1)			
Verify RNAV system required to meet RNAV 5 navigation specifications for the route and area are operational	Paragraph 10.1 a) 3)			
Verify that space-based or ground-based navigation aids required for RNAV 5 operations are available	Paragraph 10.1 a) 4)			
Revise i.e. contingencia procedures	Paragraph 10.1 a) 5)			
Indicate approval for RNAV 5 operations by annotating block 10 (Equipment) of the ICAO flight plan as defined within ICAO Doc 7030 for these operations	Paragraph 10. c)			
Verify the availability of GPS integrity RAIM for the intended flight (route and time), through the use of a prediction program either ground-based or provided as an equipment function or from an alternative method that is acceptable to the authority, in	Paragraph 10 b)			

Subjects	Reference paragraphs CA 91-002	Locations in operator exhibit	CAA recommendations and/or comments	Inspector tracking: Item status and date
the following cases: • when any GPS satellites are scheduled to be out of service; or • more than one satellite is scheduled to be out of service for GPS equipment that incorporate pressure altitude aiding.				
The operator shall not dispatch or release a flight in the event of predicated continuous loss of RAIM of more than 5 minutes for any part of the intended flight. In this case the flight may be delayed, cancelled or re-routed.	Paragraph 10 b) 7)			
Pre-flight procedures at the aircraft				
Review maintenance logs and forms for RNAV 5 status.	Paragraph 10.2 a)			
Verify navigation data base currency (current AIRAC cycle), if this data base is installed.	Paragraph 10.2 b)			
En route procedures				
Verify RNAV equipment required for RNAV 5 operation has not been degraded in flight	Paragraph 10.3 a) 1)			
Verify the route of flight correspond to the	Paragraph 10.3 a) 2)			

Subjects	Reference paragraphs CA 91-002	Locations in operator exhibit	CAA recommendations and/or comments	Inspector tracking: Item status and date
clearance				
Verify aircraft precision navigation is suitable for RNAV 5 operations through pertinent cross-checks.	Paragraph 10.3 a) 3)			
Verify others navigation aids (e. g., VOR, DME and ADF) are selected, so as to allow immediate cross-checking or reversion in the event of loss of GPS navigation capability.	Paragraph 10.3 a) 4)			
Contingency procedures	Paragraph 10.4			
The aircraft must not enter or continue operations in an airspace designated as RNAV 5, in accordance with a current clearance of ATC, if due to a failure or degradation, the navigation system is downgraded under the RNAV 5 requirements, in this event, the pilot will obtain when it is possible a amended clearance.	Paragraph 10.4 a) 1)			
In accordance with ATC instructions, the operations may continue in compliance with ATC current authorization or when it is not possible, the pilot may request an amended clearance to return to conventional VOR/DME navigation.	Paragraph 10.4 a) 2)			

Subjects	Reference paragraphs CA 91-002	Locations in operator exhibit	CAA recommendations and/or comments	Inspector tracking: Item status and date
In all cases, the flight crew must follow the contingency procedures establish for each region and obtain an ATC clearance as soon as possible.	Paragraph 10.4 a) 3)			
Contingency procedures in the event of loss of GPS navigation capability				
The contingency procedures should identify the flight crew actions required in the event of the GPS stand-alone equipment indicating a loss of the integrity monitoring detection (RAIM) function or exceedance of integrity alarm limit (erroneous position).	Paragraph 10.4 b) 1)			
Whatever contingency registered in flight must be notify to the AAC within 72 hours, unless the delay is justify.	Paragraph 10.4 b) 3)			

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APPENDIX C-1

ADVISORY CIRCULAR

AC	**:**	**91-003**
DATE	**:**	**12/10/09**
VERSION	**:**	**Original**
ISSUED BY	**:**	**SRVSOP**

SUBJECT: AIRCRAFT AND OPERATORS APPROVAL FOR RNAV 1 AND RNAV 2 OPERATIONS

ADVISORY CIRCULAR

AC	**:**	**91-003**
DATE	**:**	**12/10/09**
VERSION	**:**	**Original**
ISSUED BY	**:**	**SRVSOP**

SUBJECT: AIRCRAFT AND OPERATORS APPROVAL FOR RNAV 1 AND RNAV 2 OPERATIONS

1. PURPOSE

This advisory circular (AC) establishes the RNAV 1 and RNAV 2 approval requirements for aircraft and en-route and terminal area operations.

An operator may use alternate means of compliance, as long as such means are acceptable to the Civil Aviation Authority (CAA).

The future tense of the verb or the term “shall” apply to operators who choose to meet the criteria set forth in this AC.

2. RELEVANT SECTIONS OF THE LATIN AMERICAN AERONAUTICAL REGULATIONS (LAR) OR EQUIVALENTS

LAR 91: Sections 91.1015 and 91.1640 or equivalents

LAR 121: Section 121.995 (b) or equivalent

LAR 135: Section 135.565 (c) or equivalent

3. RELATED DOCUMENTS

Annex 6	Operation of aircraft
	Part I – International commercial air transport – Aeroplanes
	Part II – International general aviation - Aeroplanes
ICAO Doc 9613	Performance-based navigation (PBN) manual
ICAO Doc 7030	Regional supplementary procedures
ICAO Doc 8168	Aircraft operations
	Volume I: Flight procedures
	Volume II: Construction of visual and instrument flight procedures
JAA TGL - 10	Airworthiness and operational approval for precision RNAV operations in designated European airspace
FAA AC 90-100A	U.S. Terminal and en route area navigation (RNAV) operations
FAA AC 90-96A	Approval of U.S. operators and aircraft to operate under instrument flight rules (IFR) in European airspace designated for basic area navigation (B-RNAV) and precision area navigation (P-RNAV)

Spain DGAC CO 03/01 Aprobaciones de aeronavegabilidad y operacionales para operaciones RNAV de precisión (P-RNAV) en el espacio aéreo Europeo designado

4. DEFINITIONS AND ABBREVIATIONS

4.1 Definitions

a) **Aircraft-based augmentation system (ABAS).-** an augmentation system which augments and/or integrates the information obtained from the other GNSS elements with information available on board the aircraft. The most common form of ABAS is receiver autonomous integrity monitoring (RAIM).

b) **Area navigation (RNAV)**.- A navigation method that allows aircraft to operate on any desired flight path within the coverage of ground- or space-based navigation aids, or within the limits of the capability of self-contained aids, or a combination of these.

Area navigation includes performance-based navigation as well as other RNAV operations that do not meet the definition of performance-based navigation.

c) **Area navigation route**.- ATS route established to be used by aircraft with the capability of applying area navigation.

d) **Area navigation system (RNAV system)**.- An area navigation system that permits aircraft operation on any desired flight path within the coverage of ground- or space-based navigation aids or within the limits of the capability of self-contained aids, or a combination of these. An RNAV system may be included as part of the Flight Management System (FMS).

e) **Critical DME.** A distance-measuring equipment (DME) facility that, when not available, results in navigation service which is insufficient for DME/DME- and DME/DME//IRU-based operations along a specific route or procedure. For example, standard instrument departures and arrivals (SID/STAR) may be published with only two DMEs, in which case, both DMEs are critical.

f) **DME/DME (D/D) RNAV**. - Area navigation that uses the line of sight of at least two DME facilities to determine aircraft position.

g) **DME/DME/Inertial (D/D/I) RNAV**. - Area navigation that uses the line of sight of at least two DME facilities to determine aircraft position, along with an inertial reference unit (IRU) that provides sufficient position information in areas without DME coverage (DME gaps).

h) **Flight technical error (FTE)**.- The FTE is the accuracy with which an aircraft is controlled as measured by the indicated aircraft position with respect to the indicated command or desired position. It does not include blunder errors.

i) **Global navigation satellite system (GNSS)**.- A generic term used by the International Civil Aviation Organization (ICAO) to define any global position, speed, and time determination system that includes one or more main satellite constellations, such as GPS and the global navigation satellite system (GLONASS), aircraft receivers and several integrity monitoring systems, including aircraft-based augmentation systems (ABAS), satellite-based augmentation systems (SBAS), such as the wide area augmentation systems (WAAS) and ground-based augmentation systems (GBAS), such as the local area augmentation system (LAAS). Distance information will be provided, at least in the immediate future, by GPS and GLONASS.

j) **Global positioning system (GPS)**.- The United States global navigation satellite system (GNSS) that uses precise distance measurements to determine position, speed, and time anywhere in the world. GPS is made up by three elements: space, control, and user. The GPS spatial segment nominally consists of, at least, 24 satellites in 6 orbital planes. The control element consists of 5 monitoring stations, 3 ground antennas, and one master control station. The user element consists of antennas and receivers that provide the user with position, speed, and precise time.

k) **Navigation specifications**.- Set of aircraft and flight crew requirements needed to support performance-based navigation operations in a defined airspace. There are two kinds of navigation specification:

Required Navigation Performance (RNP) Specification. Area navigation specification that includes the performance control and alerting requirement, designated by the prefix RNP; *e.g.,* RNP 4, RNP APCH, RNP AR APCH.

Area Navigation (RNAV) Specification.- Area navigation specification that does not include the performance control and alerting requirement, designated by the prefix RNAV; *e.g.*, RNAV 5, RNAV 2, RNAV 1.

Note 1.- *The Manual on Performance-based Navigation (PBN) (Doc 9613), Volume II, contains detailed guidelines on navigation specifications.*

Note 2.- *The term RNP, formerly defined as "a statement of the navigation performance necessary for operation within a defined airspace", has been deleted from the Annexes to the Convention on International Civil Aviation because the RNP concept has been replaced by the PBN concept. In said Annexes, the term RNP is now only used within the context of the navigation specifications that require on-board performance control and alerting; e.g., RNP 4 refers to the aircraft and the operational requirements, including a lateral performance of 4 NM, with the requirement for on-board performance control and alerting as described in the PBN Manual (Doc 9613).*

l) **Navigation system error (NSE).-** The difference between the true position and the estimated position.

m) **Path definition error (PDE).-** The difference between the defined path and the desired path at a given place and time.

n) **Performance-based navigation (PBN)**.- Performance-based area navigation requirements for aircraft operating along an ATS route, on an instrument approach procedure, or in a designated airspace.

Performance requirements are defined in navigation specifications (RNAV and RNP specifications) in terms of the precision, integrity, continuity, availability, and functionality necessary to perform the proposed operation within the context of a particular airspace concept.

o) **Position estimation error (PEE).-** Difference between true position and estimated position.

p) **Receiver autonomous integrity monitoring (RAIM)**.- A technique used in a GPS receiver/processor to determine the integrity of its navigation signals, using only GPS signals or GPS signals enhanced with barometric altitude data. This determination is achieved by a consistency check between pseudo-range measurements. At least one additional available satellite is required with respect to the number of satellites that are needed for the navigation solution.

q) **RNAV operations**.- Aircraft operations that use area navigation for RNAV applications. RNAV operations include the use of area navigation for operations that are not performed in keeping with the PBN manual.

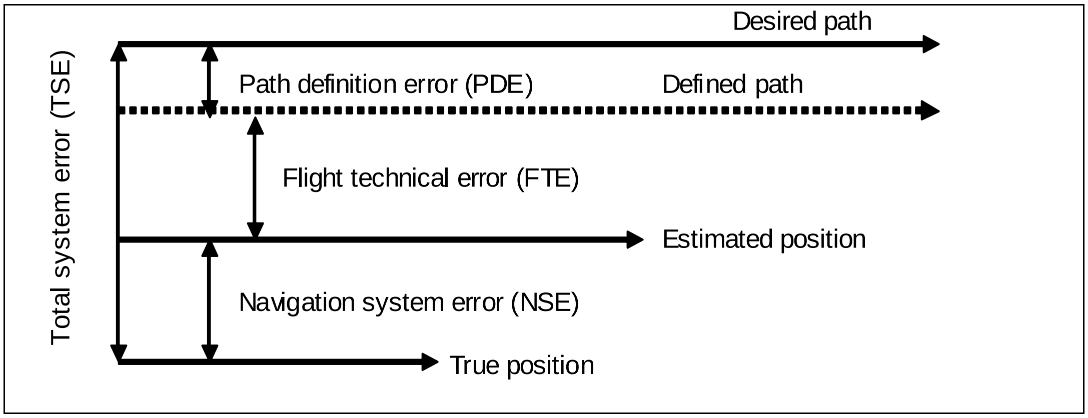
r) **Standard instrument arrival (STAR)**.- A designated instrument flight rule (IFR) arrival route linking a significant point, normally on an ATS route, with a point from which a published instrument approach procedure can be commenced.

s) **Standard instrument departure (SID).-** A designated instrument flight rules (IFR) departure route linking the aerodrome or a specified runway of the aerodrome with a specified significant point, normally on a designated ATS route, at which the en-route phase of the flight commences.

t) **Total system error (TSE).-** The difference between the true and the desired position. This error is equal to the sum of the vector of the path definition error (PDE), the flight technical error (FTE), and the navigation system error (NSE).

*Note**.-** Sometimes the FTE is referred to as the path steering error (PSE) and the NSE is referred to as the position estimation error (PEE).*

Total system error (TSE)



4.2 Abbreviations

a)	CAA	Civil Aviation Administration /Civil Aviation Authority
b)	ABAS	Aircraft-based augmentation system
c)	AC	Advisory circular (FAA)
d)	AFE	Field elevation
e)	AFM	Aircraft flight manual
f)	AHRS	Attitude and heading reference system
g)	AIP	Aeronautical information publication
h)	AIRAC	Aeronautical information regulation and control
i)	AP	Automatic pilot
j)	ANSP	Area navigation service providers
k)	ATC	Air traffic control
l)	ATM	Air traffic management
m)	ATS	Air traffic services
n)	baro-VNAV	Barometric vertical navigation
o)	B-RNAV	Basic area navigation
p)	CA	Advisory circular in Spanish (SRVSOP)
q)	CA	Course to an altitude
r)	CDI	Course deviation indicator
s)	CF	Course to a fix
t)	CNS/ATM	Communications, navigation, and surveillance/air traffic management
u)	OC	Operations circular (Spain)
v)	D/D	DME/DME
w)	D/D/I	DME/DME/IRU
x)	DF	Direct to a fix
y)	DOC	Designated operational coverage

z)	DME	Distance-measuring equipment
aa)	FD	Flight dispatcher
bb)	EASA	European Aviation Safety Agency
cc)	EHSI	Enhanced vertical status indicator
dd)	FAA	United States Federal Aviation Administration
ee)	FAF	Final approach fix
ff)	FAP	Final approach point
gg)	FD	Flight director
hh)	FM	Course from a fix to a manual termination
ii)	FMC	Flight management computer
jj)	FMS	Flight management system
kk)	FOM	Figure of merit
ll)	FTE	Flight technical error
mm)	GBAS	Ground-based augmentation system
nn)	GNSS	Global navigation satellite system
oo)	GLONASS	Global navigation satellite system
pp)	GPS	Global positioning system
qq)	GS	Ground speed
rr)	HAL	Horizontal alert limit
ss)	HSI	Horizontal status indicator
tt)	IF	Initial fix
uu)	IFR	Instrument flight rules
vv)	INS	Inertial navigation system
ww)	ILS	Instrument landing system
xx)	IRS	Inertial reference system
yy)	IRU	Inertial reference unit
zz)	LAAS	Local area augmentation system
aaa)	LAR	Latin American Aeronautical Regulations
bbb)	LNAV	Lateral navigation
ccc)	LOA	Letter of authorisation/acceptance letter
ddd)	LOC	Locator
eee)	MCDU	Multi-function control display
fff)	MEL	Minimum equipment list
ggg)	OIM	Operations inspector manual
hhh)	MLS	Microwave landing system
iii)	MP	Monitoring pilot
jjj)	MVA	Minimum vectoring altitude

kkk)	NAVAIDS	Navigation aids
lll)	NDB	Non-directional radio beacon
mmm)	NOTAM	Notice to airmen
nnn)	NSE	Navigation system error
ooo)	ICAO	International Civil Aviation Organization
ppp)	OEM	Original equipment manufacturer
qqq)	OM	Operations manual
rrr)	OpSpecs	Operations specifications
sss)	PANS-OPS	Procedures for Air Navigation Services - Aircraft Operations
ttt)	PBN	Performance-based navigation
uuu)	PDE	Path definition error
vvv)	PEE	Position estimation error
www)	PF	Pilot flying
xxx)	PNF	Pilot not flying
yyy)	POH	Pilot operating handbook
zzz)	P-RNAV	Precision area navigation
aaaa)	PSE	Path steering error
bbbb)	RAIM	Receiver autonomous integrity monitoring
cccc)	RNAV	Area navigation
dddd)	RNP	Required navigation performance
eeee)	RNP APCH	Required navigation performance approach
ffff)	RNP AR APCH	Required navigation performance approval required approach
gggg)	RTCA	Radio Technical Commission for Aviation
hhhh)	SBAS	Satellite-based augmentation system
iiii)	SID	Standard Instrument Departure
jjjj)	SL	Service letter
kkkk)	SRVSOP	Regional safety oversight cooperation system
llll)	STAR	Standard instrument arrival
mmmm)	TC	Type certificate
nnnn)	TF	Track to a fix
oooo)	TGL	Transitional guidance material
pppp)	TO/FROM	To/from
qqqq)	TSE	Total system error
rrrr)	TSO	Technical standard order
ssss)	VA	Heading to an altitude
tttt)	VI	Heading to an intercept
uuuu)	VMC	Visual meteorological conditions

vvvv)	VM	Heading to a manual termination
wwww)	VOR	VHF omnidirectional radio range
xxxx)	WAAS	Wide area augmentation system
yyyy)	WGS	World geodetic system
zzzz)	WPT	Waypoint

5. INTRODUCTION

5.1 On 1 November 2000, the European Joint Aviation Authorities (JAA) published transitional guidance material No. 10 (TGL-10) - Airworthiness and operational approval for precision RNAV (P-RNAV) operations in designated European airspace.

5.2 On 7 January 2005, the United States Federal Aviation Administration (FAA) published advisory circular (AC) 90-100 - U.S. En-route and terminal area navigation (RNAV) operations. This AC was superseded by AC 90-100A, published on 1 March 2007.

5.3 Although TGL-10 and AC 90-100A establish similar functional requirements, there are some differences between these documents.

5.4 The guidance material in this AC harmonises the European and the United States RNAV criteria under a single navigation specification called RNAV 1 and RNAV 2, in accordance with Doc 9613 – Performance based navigation (PBN) manual of the International Civil Aviation Organization (ICAO).

5.5 Operators approved under AC 90-100A meet the requirements of this CA, while operators approved under TGL-10 must confirm whether or not their aircraft systems meet the criteria set forth in this document (see Table 3-1 Appendix 6).

5.6 Current systems that comply with the two documents (TGL-10 and AC 90-100A), automatically comply with the RNAV 1 and RNAV 2 requirements set forth in this guidance material.

5.7 An operational approval issued by virtue of this document allows an operator to conduct RNAV 1 and RNAV 2 operations worldwide.

5.8 The RNAV 1 and RNAV 2 navigation specification applies to:

- all ATS routes, including those established in the en-route domain;
- standard instrument departures and arrivals (SID/STAR); and
- instrument approach procedures up to the final approach fix (FAF)/final approach point (FAP).

5.9 The final approach criteria, from the FAF to the runway threshold, along with the associated missed approach manoeuvre are not considered in this document and will be the subject of another AC.

5.10 The RNAV 1 and RNAV 2 navigation specification was mainly developed for RNAV operations in radar environments (SIDs are expected to have radar coverage prior to the first RNAV course change); however, these operations can be used in a non-radar environment or below the minimum vectoring altitude (MVA), if the CAA that implement these operations can ensure an appropriate safety system and justifies the lack of performance monitoring and alerting.

5.11 The *basic RNP 1* navigation specification is expected to be used for similar operations but outside radar coverage.

5.12 It is foreseen that en-route RNAV 1 and RNAV 2 operations will be conducted in direct controller-pilot communication environments.

5.13 Since barometric vertical navigation (baro-VNAV) is not a requirement for RNAV 1 and RNAV 2 operations, this AC does not establish approval criteria for baro-VNAV systems. RNAV 1 and RNAV 2 operations are based on normal descent profiles and identify minimum altitude requirements in the segments.

Note 1.- *Pilots operating aircraft with a baro-VNAV system can continue using this system in routes, SIDs, STARs, and approaches to the FAF. Operators will guarantee compliance with all of the limitations published in the procedure, using the barometric altimeter as reference.*

Note 2.- *Use of the aircraft barometric vertical navigation capability will be subject to the level of familiarisation and training of the flight crew, and on any other operational approval requirement.*

5.14 This AC does not include all of the requirements that may be specified for a particular operation. These requirements are established in other documents, such as, the aeronautical information publication (AIP) and ICAO Doc 7030 – Regional Supplementary Procedures.

5.15 Although operational approval is normally related to airspace requirements, operators and flight crews shall take into consideration the operational documents required by the CAA before conducting flights in RNAV 1 and RNAV 2 airspace.

5.16 The material described in this AC has been developed based on the following document:

- ✓ ICAO Doc 9613, Volume II, Part B, Chapter 3 – Implementing RNAV 1 and RNAV 2.

5.17 Where possible, this AC has been harmonised with the following documents:

- ✓ JAA TGL - 10 - Airworthiness and operational approval for precision RNAV operations in designated European airspace; y
- ✓ FAA AC 90-100A - U.S. Terminal and en route area navigation (RNAV) operations.

Note.- *Despite harmonisation efforts, operators must take note of the existing differences between this AC and the aforementioned documents when requesting an approval from the corresponding Administrations.*

6. GENERAL INFORMATION

6.1 Navigation aid infrastructure

a) This AC defines the criteria for the following RNAV systems:

- ➢ GNSS;
- ➢ DME/DME; and
- ➢ DME/DME/IRU.

b) Route design shall take into account the navigation performance that can be achieved with the navigation aid (NAVAID) infrastructure available. Although the requirements for RNAV 1 and RNAV 2 systems are identical, the NAVAID infrastructure can affect the required performance.

c) When DME is used as the only navigation service for updating position, gaps in DME coverage may prevent such update. With the inclusion of IRUs in the aircraft navigation system, an adequate level of performance can be maintained through all such gaps.

Note.- *Based on IRU performance assessment, it is expected that the increase in the position error will be less than 2NM for 15 minutes, after reverting to this system.*

d) When there is no IRU on board the aircraft, the aircraft may revert to dead reckoning navigation. In such cases, additional protection is required according to Doc 8168, Volume II – Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS) in order to compensate for the increased error.

e) According to the ICAO global air navigation plan for communications, navigation, and surveillance/air traffic management (CNS/ATM) systems (Doc 9750), the use of GNSS should be authorised whenever possible and the limitations on the use of specific system elements should be avoided.

Note.- *Most modern RNAV systems give priority to GNSS input and then DME/DME positioning. Although VOR/DME positioning is usually performed in the flight management computer (FMC) when there is no DME/DME positioning* *criteria, avionics and infrastructure variability pose serious challenges to standardisation and harmonisation. Therefore, this document only deals with GNSS, DME/DME, and DME/DME/IRU systems. This does not prevent the conduction of operations with systems that use VHF omni-directional radio range (VOR), provided they meet the criteria set forth in this AC.*

f) NAVAID infrastructure should be validated by modelling, while the expected performance should be assessed and verified through flight inspections. Assessments should consider the aircraft capabilities described in this AC. For example, a DME signal can be used if the aircraft is between 3 NM and 160 NM from the facility, below 40 degrees above the horizon (as seen from the DME facility) and if the DME/DME include angle is between 30 and 150 degrees.

g) The DME infrastructure assessment is simplified when using a screening tool which accurately matches ground infrastructure and aircraft performance, as well as an accurate representation of the terrain. Guidance material on this assessment can be found in Doc 8168, Volume II – PANS-OPS and Doc 8071 – Manual on testing of radio navigation aids.

h) It is considered that DME signals meet signal-in-space precision tolerances when these signals are received, regardless of the published coverage volume.

i) Field strength below the minimum requirement or where co-channel or adjacent channel interference may exist, are considered receiver errors. Air navigation service providers (ANSPs) shall identify errors resulting from multiple DME signal paths. When these errors exist and are not acceptable to the operation, the ANSPs can identify such NAVAIDs as not appropriate for RNAV 1 and RNAV 2 applications (so that they can be inhibited by the flight crew) or, not authorise the use of DME/DME or DME/DME/IRU systems.

j) The individual components of the navigation infrastructure must meet the performance requirements described in Annex 10 to the Chicago Convention – Aeronautical Telecommunications. Navigation aids that do not meet the requirements of Annex 10 should not be published in the State AIPs. When significant performance differences are identified in a published DME facility, RNAV 1 and RNAV 2 operations in the airspace affected by such facility should be limited to GNSS.

k) During RNAV operations based on the inertial reference system (IRS), some aircraft navigation systems revert to VOR/DME–based navigation before reverting to IRS autonomous navigation (inertial coasting). ANSPs must assess the impact of VOR radial precision when the VOR is within 40 NM of the route/procedure and when the DME/DME navigation infrastructure is not enough to ensure that aircraft position accuracy will not be affected.

l) ANSPs shall guarantee that operators of aircraft equipped with GNSS and, where applicable, with satellite-based augmentation system (SBAS), have access to a means of predicting the availability of fault detection using the aircraft-based augmentation system (ABAS) (*e.g.,* RAIM). This prediction system can be provided by an ANSP, airborne equipment manufacturers or other entities.

m) Prediction services can only be for receivers that meet the minimum performance of a technical standard order (TSO) or be specific to the receiver design. The prediction service shall use the current information from GNSS satellites and a horizontal alert limit (HAL) that is appropriate to the operation (1 NM for RNAV 1 and 2 NM for RNAV 2).

n) Outages shall be identified in case of a predicted, continuous loss of ABAS fault detection of more than 5 minutes for any part of the RNAV 1 and RNAV 2 operations. If the prediction system is temporarily unavailable, ANSPs may still allow RNAV 1 and RNAV 2 operations to be conducted, taking into account the operational repercussions of such interruptions on the aircraft or the potential risk associated with an undetected satellite failure when fault detection is not available.

o) Since DME/DME and DME/DME/IRU systems must only use DME facilities identified in the AIPs of each State, the CAAs will list in such publications the facilities that are not appropriate for RNAV 1 and RNAV 2 operations, including facilities associated to an instrument landing system (ILS) or a microwave landing system (MLS) that uses a range offset.

***Note 1.-** Database suppliers may exclude specific DME facilities when the RNAV routes are within the reception range of these facilities, which could have a deleterious effect on the navigation solution.*

***Note 2.**- When temporary restrictions occur, the publication of restrictions on the use of DME should be accomplished by use of a notice to airmen (NOTAM) to identified the need to exclude the DME.*

6.2 **ATS communications and surveillance**

a) When radar is used to assist in contingency procedures, its performance must be adequate for this purpose, *e.g.,* radar coverage, precision, continuity, and availability shall be adequate to ensure separation in the RNAV 1 and RNAV 2 ATS route structure, and provide contingency in case several aircraft are not capable of achieving the navigation performance established in the RNAV 1 and RNAV 2 navigation specification.

6.3 **Obstacle clearance and route spacing**

a) Doc 8168 (PANS OPS), Volume II, provides detailed guidance about obstacle clearance. The general criteria contained in Parts I and III of said document, will apply.

b) The CAA may prescribe either an RNAV 1 route or an RNAV 2 route. En-route spacing for RNAV 1 and RNAV 2 depends on route configuration, air traffic density, and intervention capability.

c) Until specific standards and air traffic management (ATM) procedures are developed, RNAV 1 and RNAV 2 applications can be implemented based on ATS surveillance radar.

6.4 **Publications**

a) The AIP should clearly indicate whether the navigation application is RNAV 1 or RNAV 2.

b) RNAV 1 and RNAV 2 routes, SIDs, and STARs must be based on the normal descent profiles and identify the minimum altitude requirements of the segments.

c) The available navigation infrastructure shall be clearly designated on all appropriate charts (*e.g.*, GNSS, DME/DME or DME/DME/IRU).

d) The navigation standard (*e.g*., RNAV 1 or RNAV 2) required for all RNAV procedures and routes will be clearly designated in all of the appropriate charts.

e) Any DME facility that is critical to RNAV 1 and RNAV 2 operations shall be identified in the relevant publications.

f) All routes must be based on the coordinates of the World Geodetic System - 84 (WGS-84).

g) The navigation information published in the AIP for routes and NAVAIDs must meet the requirements set forth in Annex 15 – Aeronautical Information Services.

6.5 **Additional considerations**

a) For procedure design and infrastructure assessment, it is assumed that 95% of the normal limit values of the FTE, defined in the operating procedures, are:

1) RNAV 1: 0.5 NM.

2) RNAV 2: 1 NM

b) Many aircraft have the capability of flying parallel paths displaced to the left or to the right of the original active route. The purpose of this function is to allow lateral movements for tactical operations authorised by air traffic control (ATC).

c) Likewise, many aircraft have the capability to perform a holding pattern manoeuvre using their RNAV systems. The purpose of this function is to give ATC flexibility for the designation of RNAV operations.

7. AIRWORTHINESS AND OPERATIONAL APPROVAL

7.1 For a commercial air transport operator to be granted an RNAV 1 and RNAV 2 approval, it must comply with two types of approvals:

a) the airworthiness approval, which is issued by the State of registry (see Article 31 of the Chicago Convention, and Paragraphs 5.2.3 and 8.1.1 of Annex 6 Part I); and

b) the operational approval, which is issued by the State of the operator (see Paragraph 4.2.1 and Attachment F to Annex 6 Part I).

7.2 For general aviation operators, the State of registry will determine whether or not the aircraft meets the applicable RNAV 1 and RNAV 2 requirements and will issue the operational approval (*e.g.*, letter of authorisation – LOA) (see Paragraph 2.5.2.2 of Annex 6 Part II).

7.3 Before filing the application, operators shall review all aircraft qualification requirements. Compliance with airworthiness requirements or equipment installation alone does not constitute operational approval.

8. AIRWORTHINESS APPROVAL

8.1 Aircraft requirements

8.1.1 Description of the RNAV navigation system

a) **Lateral navigation (LNAV)**

1) In LNAV, the RNAV equipment allows the aircraft to fly in accordance with the appropriate route instructions along a path defined by waypoints (WPTs) contained in an on-board navigation database.

Note.- *LNAV is normally a mode of flight guidance systems, in which the RNAV equipment provides path steering commands to the flight guidance system, which controls the FTE through the manual pilot control on a path deviation display or through the coupling of the flight director (FD) or automatic pilot (AP).*

2) For purposes of this AC, RNAV operations are based on the use of RNAV equipment that automatically determines the position of the aircraft on the horizontal plane, using data input from the following types of position sensors (not listed in a specific order of priority):

(a) GNSS in accordance with TSO-C145 (), TSO-C146 (), and TSO-C129 ()

Position data from other types of navigation sensors can be combined with GNSS data, provided they do not cause position errors that exceed total system precision requirements. Use of GNSS equipment approved by TSO-C129 () is limited to those systems that include the minimum system functions specified in Paragraph 8.4 of this CA. As a minimum, integrity should be provided by ABAS. In addition, TSO-C129 equipment must include the following additional functions:

✓ pseudo-range step detection; and

✓ health word checking.

(b) DME/DME RNAV equipment that meets the criteria listed in Paragraph 8.3.2; and

(c) DME/DME/IRU RNAV equipment that meets the criteria listed in Paragraph 8.3.4.

8.1.2 System performance, monitoring and alerting

a) **Accuracy**

1) **RNAV 1.-** For operations in RNAV 1 designated airspace or routes, total lateral system error must not exceed $\pm$ 1 NM for at least 95% of the total flight time. Likewise, along-track error must not exceed $\pm$ 1 NM for at least 95% of the total flight time.

2) **RNAV 2.-** For operations in RNAV 2 designated airspace or routes, total lateral system error must not exceed $\pm$ 2 NM for at least 95% of the total flight time. Likewise, along-track error must not exceed $\pm$ 2 NM for at least 95% of the total flight time.

b) **Integrity.-** Malfunctioning of the aircraft navigation equipment is classified as a major failure according to airworthiness regulations (*e.g.*, 10^{-5} per hour).

c) **Continuity.-** Loss of function is classified as a minor failure if the operator can revert to a different navigation system and proceed to an appropriate aerodrome.

d) **Signal-in-space**

1) **RNAV 1.-** If GNSS is used for operations in RNAV 1 designated airspace or routes, the aircraft navigation equipment must provide an alert if the probability of signal-in-space errors causing a lateral position error greater than 2 NM exceeds 10^{-7} per hour (Annex 10, Volume I, Table 3.7.2.4.1).

2) **RNAV 2.-** If GNSS is used for operations in RNAV 2 designated airspace or routes, the aircraft navigation equipment must provide an alert if the probability of signal-in-space errors causing a lateral position error greater than 4 NM exceeds 10^{-7} per hour (Annex 10, Volume I, Table 3.7.2.4.1).

8.2 **RNAV system eligibility**

8.2.1 **Aircraft with a statement of compliance with the criteria set forth in this CA.-** Aircraft with a statement of compliance with the criteria set forth in this CA or equivalent document in the AFM, the pilot operations handbook (POH), or avionics operating manual, meet the performance and functional requirements of this AC.

8.2.2 **Aircraft approved under TGL-10 and AC 90-100A**.- Aircraft approved according to both documents (TGL-10 and AC 90-100A) meet the criteria set forth in this AC.

8.2.3 **Aircraft that comply with TGL-10**.- Operators approved according to TGL-10 must confirm whether or not their aircraft systems meet the requirements set forth in this AC (see Table 3-1 of Appendix 6).

8.2.4 **Aircraft that comply with AC 90-100A.-** Aircraft that meet the criteria of AC 90-100A comply with this document.

8.2.5 **Aircraft with a statement by the manufacturer**.- Aircraft that have a statement by the manufacturer documenting compliance with the criteria of this AC or equivalent document meet the performance and functional requirements set forth in this document. This statement must include the substantiation of airworthiness compliance. The operator will determine compliance with RNAV system requirements described in Paragraph 8.3 and with the functional requirements described in Paragraph 8.4.

Note 1.- *Aircraft with demonstrated RNP capability will announce when they can no longer meet the performance requirements associated to the operations. However, for procedures based on DME/DME/IRU, the operator will determine whether or not it complies with the criteria set forth in Paragraphs 8.3.2 and 8.3.4 (DME/DME and DME/DME/IRU).*

Note 2.- *Aircraft equipped with a TSO-C129 GNSS sensor and a TSO-C115 FMS or C115a FMS might not meet the requirements set forth in this CA. The operator must assess such equipment in accordance with the performance and functional requirements set forth in this document.*

8.2.6 **Aircraft flight manual, pilot operations handbook or avionics operating manual**

(a) **Newly manufactured or modified aircraft.-** For new (capability shown in production) or modified aircraft, the AFM, POH or avionics operating manual, whichever is applicable, shall provide a statement identifying the equipment and the certified construction or modification standard for RNAV 1 and RNAV 2 operations or that the aircraft has RNP 1 capability or better.

(b) **Aircraft in use.-** For aircraft in use that are already equipped with RNAV systems but for which the AFM or POH or avionics operating manual does not define or clarify the system capability, the operator can submit documentation or a statement by the manufacturer that meets the requirements of this AC in accordance with Paragraph 8.2.4 above.

8.3 **Criteria for the approval of RNAV 1 and RNAV 2 system**

8.3.1 **Criteria for GNSS**

a) The following systems meet the precision requirements of these criteria:

1) Aircraft with TSO-C129/C129a sensor (Class B or C) and FMS that meets the criteria

established in TSO-C115b, installed for IFR use in accordance with AC 20-130A;

2) Aircraft with TSO-C145 () sensor and FMS that meets the criteria established in TSO-C115b, installed for IFR use in accordance with AC 20-130A or AC 20-138A;

3) Aircraft with Class A1 TSO-C129/C129a (without deviation from the functional requirements described in Paragraph 8.4 of this document), installed for IFR use in accordance with AC 20-138 or AC 20-138A; and

4) Aircraft with TSO-C146 () (without deviation from the functional requirements described in Paragraph 8.4 of this document), installed for IFR use in accordance with AC 20-138A.

b) For route and/or aircraft approvals that require GNSS, operators must develop procedures to check the correct operation of the GNSS when the navigation system does not automatically alert the crew about loss of such equipment.

c) The operator can integrate position information from other types of navigation sensors with the GNSS data, provided such information does not cause position errors that exceed the TSE budget; otherwise, means to cancel the selection of other types of navigation sensors shall be provided.

d) The RAIM prediction programme shall meet all the criteria established in Paragraph 12 of AC-138A.

8.3.2 **Criteria for the RNAV DME/DME system**

The criteria for assessing the DME/DME RNAV system are described in Appendix 1 to this document.

8.3.4 **Criteria for the RNAV DME/DME/IRU system**

The DME/DME/IRU RNAV system must comply with Appendix 2 to this document.

8.4 **Functional requirements – Navigation displays and functions**

The requirements contained in Appendix 3 help to guarantee that the aircraft RNAV system performance complies with the design criteria of the procedure.

8.5 **Continued airworthiness**

a) The operators of aircraft approved to perform RNAV 1 and RNAV 2 operations, must ensure the continuity of the technical capacity of them, in order to meet technical requirements established in this AC.

b) Each operator who applies for RNAV 1 and RNAV 2 operational approval shall submit to the CAA of State of registry, a maintenance and inspection program that includes all those requirements of maintenance necessary to ensure that navigation systems continue fulfilling the RNAV 1 and RNAV 2 approval criteria.

c) The following maintenance documents must be revised, as appropriate, to incorporate RNAV 1 and RNAV 2 aspects:

1) Maintenance control manual (MCM);

2) Illustrated parts catalogs (IPC); and

3) Maintenance program.

d) The approved maintenance program for the affected aircrafts should include maintenance practices listed in maintenance manuals of the aircraft manufacturer and its components, and must consider:

1) that equipment involved in the RNAV 1 and RNAV 2 operation should be maintained according to directions given by manufacturer's components;

2) that any amendment or change of navigation system affecting in any way RNAV 1 and

RNAV 2 initial approval, must be forwarded and reviewed by the CAA for its acceptance or approval of such changes prior to its implementation; and

3) that any repair that is not included in the approved/accepted maintenance documentation, and that could affect the integrity of navigation performance, should be forwarded to the CAA for acceptance or approval thereof.

e) Within the RNAV maintenance documentation should be presented the training program of maintenance personnel, which inter alia, should include:

1) PBN concept;

2) RNAV 1 and RNAV 2 application;

3) equipment involved in a RNAV 1 and RNAV 2 operation; and

4) MEL use.

9. OPERATIONAL APPROVAL

Airworthiness approval alone does not authorise an applicant or operator to conduct RNAV 1 and RNAV 2 operations. In addition to the airworthiness approval, the applicant or operator must obtain an operational approval to confirm the suitability of normal and contingency procedures in connection to the installation of a given piece of equipment.

Concerning commercial air transport, the assessment of an application for RNAV 1 and RNAV 2 operational approval is done by the State of the operator, in accordance with standing operating rules (*e.g.*, LAR 121.995 (b) and LAR 135.565 (c) or equivalent) supported by the criteria described in this CA.

For general aviation, the assessment of an application for RNAV 1 and RNAV 2 operational approval is carried out by the State of registry, in accordance with standing operating rules (*e.g.*, LAR 91.1015 and LAR 91.1640 or equivalent) supported by the criteria described in this CA.

9.1 Requirements to obtain operational approval

9.1.1 In order to obtain RNAV 1 and RNAV 2 approval, the applicant or operator will take the following steps, taking into account the criteria established in this paragraph and in Paragraphs 10, 11, 12, and 13:

a) *Airworthiness approval*.- aircraft shall have the corresponding airworthiness approvals, pursuant to Paragraph 8 of this AC.

b) *Application*.- The operator shall submit the following documentation to the CAA:

1) *RNAV 1 and RNAV 2 operational approval application;*

2) *Description of aircraft equipment*.- The operator shall provide a configuration list with details of the relevant components and the equipment to be used for RNAV 1 and RNAV 2 operations. The list shall include each manufacturer, model, and equipment version of GNSS, DME/DME, DME/DME/IRU equipment and software of the installed FMS.

3) *Airworthiness documents related to aircraft eligibility*.- The operator shall submit relevant documentation, acceptable to the CAA, showing that the aircraft is equipped with RNAV systems that meet the RNAV 1 and RNAV 2 requirements set forth in this CA, as described in Paragraph 8, for example, the parts of the AFM or AFM supplement that contain the airworthiness statement.

4) *Training programme for flight crews and flight dispatchers (FD)*

(a) Commercial operators (*e.g.*, LAR 121 and LAR 135 operators) must submit to the CAA the RNAV 1 and RNAV 2 training syllabus to show that the operational procedures and practices and the training aspects described in Paragraph 11 have been included in the initial, promotional or periodic training programmes for flight crews and FDs.

***Note.-** It is not necessary to establish a separate training programme if the RNAV 1 and RNAV 2 training identified in Paragraph 11 has already been included in the training programme of the operator. However, it must be possible to identify what aspects of RNAV are covered in the training programme.*

(b) Private operators (*e.g.*, LAR 91 operators) shall be familiar with and demonstrate that they will perform their operations based on the practices and procedures described in Paragraph 11.

5) *Operations manual and checklists*

(a) Commercial operators (*e.g.*, LAR 121 and 135 operators) must review the operations manual (OM) and the checklists in order to include information and guidance on the standard operational procedures detailed in Paragraph 10 of this AC. The appropriate manuals must contain the operation instructions for navigation equipment and contingency procedures. The manuals and checklists must be submitted for review along with the formal application in Phase two of the approval process.

(b) Private operators (*e.g.*, LAR 91 operators) must operate their aircraft based on the practices and procedures identified in Paragraph 10 of this AC.

6) *Minimum Equipment List (MEL)*.- The operator will send to the CAA for approval any revision to the MEL that is necessary for the conduction of RNAV 1 and RNAV 2 operations. If an RNAV 1 and RNAV 2 operational approval is granted based on a specific operational procedure, operators must modify the MEL and specify the required dispatch conditions.

7) *Maintenance*.- The operator will submit for approval a maintenance programme for the conduction of RNAV 1 and RNAV 2 operations.

8) *Training programme for maintenance personnel*.- Operators will submit the training curriculum that corresponds to maintenance personnel in accordance with Paragraph 8.5 e).

9) *Navigation data validation programme*.- Operators will present details about the navigation data validation programme as described in Appendix 4 to this CA.

c) *Training programme*.- Once the amendments to manuals, programmes, and documents submitted have been accepted or approved, the operator will provide the required training to its personnel.

d) *Validation flight*.- The CAA may deem it advisable to perform a validation flight before granting the operational approval. Such validation can be performed on commercial flights. The validation flight will be carried out according to the provisions of Chapter 13, Volume II, Part II of the SRVSOP Operations Inspector Manual (MIO).

e) *Issuance of the approval to conduct RNAV 1 and RNAV 2 operations*.- Once the operator has successfully completed the operational approval process, the CAA will grant the operator approval to conduct RNAV 1 and RNAV 2 operations.

1) LAR 121 and/or 135 operators.- For LAR 121 and/or LAR 135 operators, the CAA will issue the corresponding operations specifications (OpSpecs) that will reflect the RNAV 1 and RNAV 2 approval.

2) *LAR 91 operators*.- For LAR 91 operators, the CAA will issue a letter of authorisation (LOA).

10. OPERATING PROCEDURES

10.1 Operators and flight crews will become familiar with the following operating and contingency procedures associated with RNAV 1 and RNAV 2 operations.

a) **Pre-flight planning**

1) Operators and pilots intending to conduct operations on RNAV 1 and RNAV 2 routes must fill out the appropriate boxes in the ICAO flight plan.

2) On-board navigation data must be current and appropriate for the region of intended operations and will include NAVAIDS, WPTs, and the relevant ATS route codes for arrivals, departures, and alternate aerodromes. RNAV STAR procedures can be designated using multiple runway transitions. Operators that lack this function will provide an alternate means of compliance (for example, a navigation database adjusted for these operations). If there is no alternate means of compliance to fly an RNAV designated procedure that contains multiple runway transitions, operators will not submit or accept an approval for these procedures.

Note.- *It is expected that the navigation database will be up to date during the operation. If the AIRAC cycle expires during the flight, operators and pilots shall establish procedures to ensure the precision of navigation data, including the suitability of navigation facilities used to determine the routes and procedures for the flight. Normally, this is done comparing electronic data with written documents. An acceptable means of compliance is to compare aeronautical charts (new and old) to check navigation reference points before dispatch. If an amended chart is published for the procedure, the database must not be used to conduct the operation.*

3) The availability of the navigation infrastructure required for the intended routes, including any non-RNAV contingency, must be confirmed for the foreseen period of the operation, using all available information. Since Annex 10 Volume I requires GNSS integrity (RAIM or SBAS), it is also necessary to confirm adequate availability of these devices.

4) Aircraft not equipped with GNSS.- Aircraft not equipped with GNSS shall be capable of updating the DME/DME and DME/DME/IRU position for RNAV 1 and RNAV 2 routes and for SIDs and STARs.

5) If only TSO-C129 equipment is used to meet RNAV 1 and RNAV 2 requirements, it is necessary to confirm RAIM availability for the flight route (route and time) foreseen, using current GNSS satellite information.

6) If only TSO-C145/C146 equipment is used to meet RNAV requirements, the pilot/operator does not need to make any prediction if it is confirmed that the wide area augmentation system (WAAS) coverage is available along the entire flight route.

Note.- *For areas where WAAS coverage is not available, operators that use TSO-C145/C146 receivers must confirm the GNSS RAIM availability.*

7) RAIM (ABAS) availability

(a) The RAIM levels required for RNAV 1 and RNAV 2 operations may be verified, either through NOTAMs (when available) or through prediction services. Operators must become familiar with the prediction information available for the intended route.

(b) The available RAIM prediction must take into account the latest usable NOTAMs and the avionics model (if available). The RAIM prediction service can be provided through the ANSPs, the avionics manufacturers, other entities, or through an on-board RAIM prediction receiver.

(c) In the event of a predicted, continuous loss of appropriate level of fault detection of more than five (5) minutes for any part of the RNAV 1 and RNAV 2 operation, the flight plan shall be revised (*e.g.*, delaying the departure or planning a different departure procedure).

(d) The RAIM availability prediction software does not guarantee the service. This software is rather a tool for assessing the expected capacity to meet the required navigation performance. Due to unplanned failures of some GNSS elements, pilots and ANSPs must understand that both RAIM and GNSS navigation can be lost while the aircraft is on flight, which may require reversal to an alternate means of navigation. Therefore, pilots must assess their navigation capabilities (potentially to an alternate aerodrome) in case of failure of GNSS navigation.

8) DME availability

(a) For DME-based navigation, it is necessary to check the NOTAMs to confirm the status of critical DMEs. Pilots must assess their navigation capabilities (potentially to an alternative aerodrome) if a critical DME fails while the aircraft on flight.

b) **General operating procedures**

1) Operators and pilots shall not apply for or submit RNAV1 and RNAV 2 routes, SIDs or STARs in the flight plan, unless they meet all the criteria set forth in this AC. If an aircraft that does not meet these criteria is cleared by the ATC to conduct an RNAV procedure, the pilot will notify the ATC that it cannot accept such clearance and will request alternate instructions;

2) The pilot will comply with any instruction or procedure identified by the manufacturer, as necessary, to meet the performance requirements set forth in this section;

3) At system initialization, pilots must:

(a) confirm that the navigation database is up-to-date;

(b) verify the current position of the aircraft;

(c) verify the appropriate entry of the assigned ATC route once they receive the initial clearance, and of any subsequent change in route; and

(d) ensure that the sequence of WPTs as depicted in their navigation system matches the route drawn in the appropriate charts and the assigned route.

4) Pilots shall not fly an RNAV 1 or RNAV 2 SID or STAR, unless it can be retrieved from the on-board navigation database using the name of the procedure, and coincides with the procedure in the chart. However, the route can be modified afterwards by inserting or deleting specific WPTs in response to ATC clearance. Manual entry or the creation of new WPTs through manual insertion of latitude and longitude or rho/theta values is not permitted. Likewise, pilots must not change any RNAV SID or STAR database WPT type from a fly-by WPT to a flyover WPT or *vice versa*.

5) Whenever possible, RNAV 1 or RNAV 2 routes must be obtained from the database as a whole, instead of individually loading the route WPTs from the database to the flight plan. However, the individual selection and insertion of designated fixes and WPTs from the navigation database is permitted, provided all the fixes along the published route to be flown are inserted. Likewise, the route can be modified afterwards through the insertion or deletion of specific WPTs in response to ATC clearance. Manual entry or the creation of new WPTs through the manual insertion of latitude and longitude or rho/theta values is not permitted.

6) Flight crews shall cross-check the cleared flight plan by comparing charts or other applicable resources to the navigation system text displays and aircraft chart displays, as applicable. If required, the exclusion of specific NAVAIDs must be confirmed. A procedure shall not be used if there are any doubts about the validity of the procedure in the navigation database.

Note.- *Pilots may note a small difference between the navigation information described in the chart and the primary navigation display. Differences of 3° or less may result from the equipment manufacturer's application of magnetic variation and are operationally acceptable.*

7) During the flight, whenever feasible, the flight crew must use the information available from the NAVAIDs ground-based to confirm navigation reasonableness.

8) For RNAV 2 routes, pilots must use a lateral deviation indicator, an FD or an AP on lateral navigation mode. Pilots may use a navigation chart display with functionality equivalent to a lateral deviation indicator without an FD or AP.

9) For RNAV 1 routes, pilots must use a lateral deviation indicator, an FD or an AP on lateral navigation mode.

10) Pilots of aircraft with a lateral deviation display must make sure that the lateral deviation scale is suitable for the navigation accuracy associated to the route/procedure (*e.g.*, full-scale deflection: ± 1 NM for RNAV 1, ± 2 NM for RNAV 2 or ± 5 NM for TSO-C129 () equipment in RNAV 2 routes).

11) All pilots are expected to follow the route centreline, as represented on the on-board lateral deviation indicators and/or flight guidance, during all RNAV 1 and RNAV 2 operations, unless cleared by the ATC to deviate or due to an emergency. For normal operations, the cross-track error/deviation (the difference between the RNAV system computed path and the aircraft position relative to the path) must be limited to ± ½ the navigation precision associated with the route or flight procedure (*e.g.*, 0.5 NM for RNAV 1 and 1.0 NM for RNAV 2). Small lateral deviations from this requirement are allowed (*e.g.*, overshooting or undershooting the path) during or immediately after an en-route turn/procedure, up to a maximum of 1 times (1xRNP) the navigation precision (*e.g.*, 1 NM for RNAV 1 and 2 NM for RNAV 2).

Note.- *Some aircraft do not display or do not estimate a path during turns. Pilots of such aircraft may not be capable of meeting the ± ½ precision requirement during en-route turns; however, they are expected to meet interception requirements after the turn or in straight segments.*

12) If the ATC issues a heading assignment that places the aircraft out of the route, the pilot shall not modify the flight plan in the RNAV system until a new clearance is received allowing the aircraft to return to the route or until the controller confirms a new route clearance. When the aircraft is not on the published route, the specified precision requirements will not apply.

13) Manual selection of functions that limit the banking angle of the aircraft can reduce the ability of the aircraft to maintain its desired track and is not recommended. Pilots should acknowledge that manual selection of functions that limit the banking angle of the aircraft could reduce their ability to meet ATC path expectations.

14) Pilots operating aircraft with RNP approval in accordance with the provisions of this AC do not need to modify the predetermined RNP values of the manufacturer established in the FMC.

c) **RNAV SIDs specific requirements**

1) Before beginning take-off, the pilot must verify that the airborne RNAV system is available and operating correctly, and that the appropriate aerodrome and runway data have been loaded. Before the flight, pilots must verify that the airborne navigation system is operating correctly and that the appropriate runway and departure procedure (including any applicable en-route transition) have been loaded and are duly displayed. Pilots assigned to an RNAV departure procedure and subsequently receive a change of runway, procedure or transition, must verify that the appropriate changes have been entered and are available for navigation before take-off. A final check of proper runway entry and correct route depiction, shortly before take-off, is recommended.

2) *Altitude for connecting the RNAV equipment*.- The pilot must be capable of connecting the RNAV equipment in order to follow the flight guidance in the RNAV lateral navigation mode before reaching 153 m (500 ft) above the aerodrome elevation. The altitude at which the RNAV guidance on a route begins can be higher (*e.g.*, climb to 304 m (1 000 ft) then direct to…)

3) Pilots must use an authorised method (lateral deviation indicator/navigation chart display /FD/AP) to achieve appropriate level of performance for RNAV 1.

4) *DME/DME aircraft.*- Pilots of aircraft without GNSS that use DME/DME sensors without inertial input cannot use their RNAV systems until the aircraft is under the appropriate

DME coverage. The ANSP will make sure that adequate DME coverage is available in every (DME/DME) RNAV SID.

5) *DME/DME/IRU aircraft.-* Pilots of aircraft without GNSS that use DME/DME RNAV systems with an IRU (DME/DME/IRU) must make sure that the position in the inertial navigation system (INS) is within 304 m (1 000 ft/0.17 NM) from a known position at the starting point of the take-off roll. This is usually achieved through the use of a manual or automatic runway updating function. The navigation chart can also be used to confirm the position of the aircraft if the pilot procedures and the display resolution allow compliance with the 304 m (1 000 ft) tolerance requirement.

Note.- *Based on the assessment of IRU performance, the increase of the position error after reverting to IRU can be expected to be less than 2 NM per 15 minutes.*

6) *GNSS aircraft.-* When a GNSS is used, the signal must be obtained before starting the take-off roll. For aircraft using TSO-C129/C129a equipment, the take-off aerodrome must be loaded in the flight plan in order to achieve monitoring and the appropriate navigation system sensitivity. For aircraft using TSO-C145a/C146a avionics, if the departure begins at a runway waypoint, then the departure airport does not need to be in the flight plan to obtain appropriate monitoring and sensibility.

d) **RNAV STARs specific requirements**

1) Before the arrival phase, the flight crew shall verify that the correct terminal route has been loaded. The active flight plan shall be checked, comparing the charts to the chart display (if applicable) and the MCDU. This includes confirmation of WPT sequence, the reasonableness of track angles and distances, any altitude or speed constraints, and, whenever possible, which are fly-by WPTs and which are flyover WPTs. If required by a route, it will be necessary to confirm that the update will exclude a particular NAVAID. A route will not be used if there are any doubts about its validity in the navigation database.

Note.- *As a minimum, verifications in the arrival phase could consist of simple inspections of an appropriate chart display that will meet the objectives of this paragraph.*

2) The creation of new WPTs by the flight crew through manual entries into the RNAV system will invalidate any route, and is not permitted.

3) Where contingency procedures require reversion to a conventional arrival route, the flight crew must complete the necesary preparations before commencing the RNAV route.

4) Route modification in the terminal area may take the form of radar headings or “direct to” clearances. In this sense, the flight crew must be capable of reacting in time. This may include the insertion of tactical WPTs loaded from the database. The flight crew is not allowed to make manual entries or to modify a loaded route, using temporary WPT or fixes not provided in the database.

5) Pilots must verify that the aircraft navigation system is operating properly and that the correct arrival procedure and runway are properly inserted and displayed.

6) Although a specific method has not been established, any altitude or speed constraints shall be observed.

e) **Contingency procedures**

1) The pilot must notify the ATC of any loss of RNAV capability, together with the proposed course of action. If it is not possible to meet the requirements of an RNAV route, pilots must notify the ATS as soon as possible. Loss of RNAV capability includes any failure or event that causes the aircraft to be unable to meet the RNAV requirements of the route.

2) In case of a communication failure, the flight crew must continue on the RNAV route, according to the established procedure for lost communication.

11. TRAINING PROGRAMME

11.1 The training programme for flight crews and flight dispatchers (DV) shall provide sufficient training (*e.g.*, using flight training devices, flight simulators, and aircraft) on the RNAV system to the extent necessary. The training programme will include the following topics:

a) information about this CA;

b) the meaning and proper use of aircraft equipment and navigation suffixes;

c) the characteristics of procedures, as determined in chart displays and in the text description;

d) the representation of the types of WPTs (fly-by and fly-over) and ARINC 424 path terminations provided in Paragraph 8.4 and any other type used by the operator, as well as those associated with the aircraft flight paths;

e) the navigation equipment required to operate in RNAV 1 and RNAV 2 routes, SIDs and STARs (*e.g.*, GNSS, DME/DME and DME/DME/IRU).

f) specific information on the RNAV system:

   1) levels of automation, annunciation modes, changes, alerts, interactions, reversals, and degradation;

   2) integration of functions with other aircraft systems;

   3) the meaning and convenience of en-route discontinuities, as well as procedures related to the flight crew;

   4) pilot procedures consistent with the operation;

   5) types of navigation sensors (*e.g.*, GNSS, DME, IRU) used by the RNAV system and establishment of priorities, weighting, and consistency with associated systems;

   6) turns anticipation taking into account the effects of speed and altitude;

   7) interpretation of electronic displays and symbols;

   8) understanding aircraft configuration and the operating conditions required to support RNAV operations, *e.g.*, appropriate selection of CDI scale (lateral deviation display scale);

g) operating procedures for RNAV equipment, as applicable, including how to carry out the following:

   1) verify currency and integrity of aircraft navigation data;

   2) verify the successful completion of RNAV system self-test;

   3) initialize RNAV system position;

   4) retrieve and fly a SID or STAR with the appropriate transition;

   5) adhere to speed and altitude constraints associated with a SID or STAR;

   6) select the appropriate SID or STAR for the active runway and become familiar with the procedures to deal with a runway change;

   7) perform a manual or automatic update (with take-off point shift, if applicable);

   8) verify the WPTs and flight plan programming;

   9) fly direct to a WPT;

   10) fly a course/track to a WPT;

   11) intercept a course/track;

   12) fly radar vectors and return to an RNAV route from a “heading” mode;

   13) determine cross-track errors and deviations;

14) resolve en-route discontinuities (insert and delete/eliminate en-route discontinuities);

15) remove or reselect the navigation sensor inputs;

16) when required, confirm the exclusion of a specific NAVAID or any type of navigation aid;

17) when required by the CAA, performs gross navigation errors checks using conventional NAVAIDs;

18) change the arrival and alternate aerodromes;

19) perform parallel offset functions if that capability is available. Pilots must know how offset are applied, the functionality of the particular RNAV system, and the need to advise the ATC if this functionality is not available; and

20) perform RNAV holding functions (*e.g.*, insert or delete a holding pattern).

h) levels of automation recommended by the operator for each flight phase and workload, including the methods to minimise cross-track error that permit the aircraft to follow the route centreline;

i) radiotelephony phraseology used for RNAV applications; and

j) contingency procedures for RNAV failures.

12. NAVIGATION DATABASE

a) The operator must obtain the navigation database from a supplier that complies with document RTCA DO 200A/EUROCAE ED 76 – Standards for aeronautical data processing. Navigation data must be compatible with the intended function of the equipment (see Annex 6 Part I paragraph 7.4.1). A letter of acceptance (LOA) issued by the appropriate regulatory authority to each participant in the data chain shows compliance with this requirement (*e.g.*, FAA LOA issued in accordance with FAA AC 20-153, or EASA LOA issued in accordance with EASA IR 21 Subpart G).

b) The operator must advise the navigation data supplier of discrepancies that invalidate a route, and prohibit the use of the affected procedures through a notice to flight crews.

c) Operators should consider the need to check the navigation database periodically in order to maintain the existing requirements of the quality system or safety management system.

d) DME/DME RNAV systems must only use the DME facilities identified in CAA AIPs.

e) Systems must not use the facilities indicated by the CAA as inappropriate for RNAV 1 and RNAV 2 operations in the AIP, or facilities associated with an ILS or MLS that uses a range offset. This can be done excluding the specific DME facilities known to have a detrimental effect on the navigation solution from the aircraft database, when RNAV routes are within the receiving range of such DME facilities.

13. OVERSIGHT, INVESTIGATION OF NAVIGATION ERRORS, AND WITHDRAWAL OF RNAV 1 and RNAV 2 APPROVAL

a) The operator will establish a procedure to receive, analyse, and follow up on navigation error reports in order to determine appropriate corrective action.

b) Information indicating a potential for repetitive errors may require the modification of the training programme of the operator.

c) Information attributing multiple errors to a pilot in particular may call for additional training or a license review for that pilot.

d) Repetitive navigation errors attributed to the equipment or a specific part of the navigation equipment or to operating procedures can be the cause of cancellation of an operational approval (withdrawal of RNAV 1 and RNAV 2 IPSec authorisation or withdrawal of the LOA in the case of private operators).

APPENDIX 1

CRITERIA FOR THE APPROVAL OF RNAV SYSTEMS THAT USE DME

(DME/DME RNAV SYSTEM)

1. PURPOSE

The CAA is responsible for assessing DME coverage and availability in accordance with the minimum standards of the DME/DME RNAV system for each route and procedure. Detailed criteria are needed to define DME/DME RNAV system performance, since that system is related to DME infrastructure. This Appendix describes the minimum DME/DME RNAV system performance and functions required to support the implementation of RNAV 1 and RNAV 2 routes, SIDs, and STARs. These criteria must be used for the airworthiness approval of new equipment or can be used by manufacturers for the certification of their existing equipment.

2. MINIMUM REQUIREMENTS FOR DME/DME RNAV SYSTEMS

Paragraph	Criteria	Explanation
a)	Accuracy is based on the performance standards set forth in TSO-C66c	
b)	Tuning and updating position of DME facilities	The DME/DME RNAV system must: 1) update its position within 30 seconds of tuning on DME navigation facilities; 2) auto-tune multiple DME facilities; and 3) provide continuous DME/DME position updating. If a third DME facility or a second pair has been available for at least the previous 30 seconds, there must be no interruption in DME/DME positioning when the RNAV system switches between DME stations/pairs.
c)	Use of facilities contemplated in State AIPs	DME/DME RNAV systems must only use the DME facilities identified in the State AIPs. Systems must not use the facilities that States list in their AIPs as not appropriate for RNAV 1 and/or RNAV 2 operations, or facilities associated to an ILS or MLS that uses a range offset. This can be done through: 1) Excluding specific DME facilities which are known to have a deleterious effect on the navigation solution from the aircraft navigation database when RNAV routes are within the reception range of said DME facilities. 2) the use of an RNAV system that conducts reasonableness checks to detect errors in all of the DME facilities and excludes those facilities from the navigation position solution as appropriate (*e.g.*, preclude tuning on co-channel signal facilities when the DME facilities signal-in-space overlap).

<table>
<tr><th>Paragraph</th><th>Criteria</th><th>Explanation</th></tr>
<tr><td>d)</td><td>DME facilities relative angles</td><td>When it is necessary to generate a DME/DME position, the RNAV system must use, as a minimum, DMEs with a relative angle between 30° and 150°.</td></tr>
<tr><td>e)</td><td>Use of DMEs through the RNAV system</td><td>The RNAV system may use any valid (listed in the AIP) DME facility, regardless of its location. A valid DME facility:
1) issues a precise signal that identifies the facility;
2) meets the minimum signal intensity requirements; and
3) is protected against interference from other DME signals, in accordance with co-channel and adjacent channel requirements.
When needed to generate a DME/DME position, as a minimum, the RNAV system must use an available and valid low altitude and/or high altitude DME anywhere within the following region around the DME facility:
1) greater than or equal to 3 NM from the facility; and
2) less than 40° above the horizon when viewed from the DME facility and at a distance of 160 NM.
Note.- The use of a figure-of-merit (FOM) in approximating the designated operational coverage (DOC) of particular facilities is acceptable, provided precautions are taken to ensure that the FOM is coded in such a way that the aircraft can use the facility anywhere within the DOC. The use of DMEs associated with ILS or MLS is not required..</td></tr>
<tr><td>f)</td><td>No requirement to use VOR, NDB, LOC, IRU or AHRS</td><td>There is no requirement to use VOR, non-directional radio beacon (NDB), localizer (LOC), IRU or attitude and heading reference system (AHRS) during normal operation of the DME/DME RNAV system.</td></tr>
<tr><td>g)</td><td>Position estimation error (PEE)</td><td>When using a minimum of two DME facilities that meet the criteria contained in Paragraph e) above and any other valid facility that does not meet such criteria, the position estimation error during 95% of the time must be better than or equal to the following equation:
$$2\sigma_{DME/DME} \leq 2\frac{\sqrt{(\sigma^2_{1,air}+\sigma^2_{1,sis})+(\sigma^2_{2,air}+\sigma^2_{2,sis})}}{\sin(\alpha)}$$
where: σ_{sis} = 0.05 NM
σ_{air} is MAX {(0.085 NM, (0.125% of the distance)}
α = angle of inclusion (30^o to 150^o)
Note.- This performance requirement can be met by any navigation system that uses two DME facilities simultaneously, limits the DME inclusion angle between 30° and 150° and uses DME sensors that meet TSO-C66c precision requirements. If the RNAV system uses DME facilities outside of the published designated operational coverage, it can still be assumed that the DME signal-in-space error of valid facilities is σ_{gorund} = 0.05 NM.</td></tr>
<tr><td>h)</td><td>Preventing</td><td>The RNAV system must ensure that the use of facilities</td></tr>
</table>

Paragraph	Criteria	Explanation
	erroneous guidance from other facilities	outside the service volume (where field intensity and common or adjacent interference requirements cannot be met) do not cause misguidance. This could be achieved by including reasonableness checks when initially tuning on a DME facility, or by excluding a DME facility when there is a co-channel DME within line-of-sight.
i)	Preventing erroneous VOR signals-in-space	The RNAV system can use a VOR. However, the RNAV system must make sure that an erroneous VOR signal-in-space does not affect the position error when the system is within DME/DME coverage. This can be achieved by monitoring the VOR signal with DME/DME to make sure that it does not mislead position results (*e.g.*, through reasonableness checks).
j)	Ensuring RNAV systems use operational facilities	The RNAV system must use operational DME facilities. DME facilities listed in the NOTAMs as inoperative (for example, being tested or undergoing maintenance) could still reply to on-board interrogation. Consequently, inoperative facilities must not be used. An RNAV system can exclude inoperative DME facilities by verifying the identification code or inhibiting the use of facilities identified as inoperative.
k)	Operational mitigation	Operational mitigations, such as the monitoring by pilots of the sources to update the RNAV navigation system, or time scheduling, or the exclusion of multiple DME facilities, should be performed before any period of intensive workload or any critical flight phase. ***Note.-*** *The exclusion of individual facilities listed in the NOTAMS as out of service and/or the programming of a route/procedure defined as critical DME is acceptable when such mitigation does not require action by the pilot during a critical phase of the flight. Likewise, a programming requirement does not imply that the pilot should manually enter the DME facilities that are not in the navigation database.*
l)	Reasonableness checks	Many RNAV systems perform reasonableness checks to verify the validity of DME measurements.- Reasonableness checks are very effective against database errors or erroneous system inputs (such as, inputs from co-channel DME facilities) and normally can be divided into two classes: 1) the ones the RNAV system uses after a new DME has been captured, where the system compares the aircraft's position before using the DME with the range of the aircraft to that DME; and 2) the ones the RNAV system continuously uses, based on redundant information (for example, additional DME signals or IRU information). **General requirements** Reasonableness checks are intended to prevent navigation aids from being used for navigation updating in areas where data can lead to errors in the radio position fix due to co-channel interference, multipath, and direct signal screening.

Paragraph	Criteria	Explanation
		Instead of using the service volume of NAVAIDs, the navigation system must provide checks that preclude the use of duplicate frequencies of the NAVAIDs within range, over-the-horizon NAVAIDs, and NAVAIDs with poor geometry. **Assumptions.-** Under certain conditions, reasonableness checks can be invalid. 1) A DME signal will not remain valid just because it was valid when captured. 2) *Additional DME signals might not be available.* The intent of this specification is to support operations where infrastructure is minimal (for example, when only two DMEs are available for en-route segments). ***Use of stressing conditions to test the effectiveness of the verification***.- When a reasonableness check is used to meet any requirement of these criteria, the effectiveness of the check must be tested under extreme conditions. An example of this condition is when a DME signal, valid when captured, becomes distorted during the test, when there is only one supporting DME or two signals of equal strength.

3. PROCESS TO CONFIRM THE PERFORMANCE OF RNAV SYSTEMS THAT USE DME

New systems may demonstrate compliance with these criteria as part of the airworthiness approval. For existing systems, operators shall determine compliance with the equipment and aircraft criteria set forth in this AC based on the information provided by aircraft and equipment manufacturers. Manufacturers that have achieved compliance with the requirements of paragraph (8.3.2) above and of this paragraph (8.3.3) shall provide this information through a letter to their customers. Operators may use this approval as the basis for their operations. Manufacturers will also be required by the CAA to provide a copy of the aforementioned letter in order to facilitate making this information available to all operators. Guidance is provided below for aircraft and FMS and DME manufacturers.

a) **Aircraft manufacturers (type certificate (TC) holders that incorporating FMS and DME/DME positioning).-** The manufacturer shall review the available data on the integrated navigation system and shall obtain additional data, as appropriate, to determine compliance with the criteria set forth in this AC. Manufacturers that have achieved compliance with these criteria shall provide this information by letter to their customers. Manufacturers are also requested to provide a copy of this letter to the CAA in order to facilitate making this information available to all operators.

b) **Equipment manufacturers (normally individual DME and/or FMS TSO holders)**

1) **DME sensor**.- The only requirement in this paragraph (8.3.3) that needs to be considered for a DME sensor is accuracy. DME sensors have been tested for a variety of performance requirements of TSO-C66 – Distance-measuring equipment (DME) that operates within the radio frequency range of 960-1215 megahertz and documents of the Radio Technical Commission for Aeronautics (RTCA).

(a) TSO-C66 performance standards have evolved as follows:

(1) TSO-C66: (August 1960) RTCA/DO99.

(2) TSO-C66a: (September 1965) RTCA/DO151, accuracy requirement of a total error of 0.1 NM attributed to the ground facility, an accuracy of 0.5 NM for

airborne equipment or 3% distance, whichever is greater, with a maximum of 3 NM.

(3) TSO-C66b: (November 1978) RTCA/DO151a, accuracy requirement of a total error of 0.1 NM attributed to the ground facility, an accuracy of 0.5 NM for airborne equipment or 1% of the distance, whichever is greater, with a maximum of 3 NM.

(4) TSO-C66c: (September 1985) RTCA/DO189, accuracy requirement as total error for the airborne equipment of 0.17 NM or 0.25% of distance, whichever is greater.

(b) **TSO-C66c required precision.-** The accuracy required by TSO-C66c is adequate to support the criteria of this section and AC, and DME equipment manufacturers under this TSO version do not need to further assess their equipment for RNAV 1 and RNAV 2 operations. DME sensor manufacturers may use the following process to establish a more precise performance than originally credited:

(1) **Determination of the precision achieved.**- Rather than relying on the originally demonstrated performance, the applicant may choose to make a revision under the original TSO, TC data, or TC supplement to determine proven accuracy, and/or make any appropriate changes to qualification tests to determine the precision achieved.

***Note.-** When conducting the precision analysis, the DME signal-in-space error can be assumed to be 0.1 NM 95% of the time. If accuracy is demonstrated on a test bench or under flight test conditions, the accuracy of the test bench equipment or ground facility must be considered.*

(2) **Accomplishing new testing.**- New tests must be conducted under the same conditions used to demonstrate compliance with the original TSO-C66 standard.

(3) Manufacturers who have demonstrated a more precise DME performance shall indicate the demonstrated accuracy in a letter to their customers. Manufacturers shall also provide copy of this letter to the CAA to facilitate making this information available to all operators.

2) **Multi-sensor systems.-** The manufacturer shall review the data on the integrated navigation system and obtain additional data, as appropriate, to comply with the criteria contained in Paragraphs 8.3.2 and 8.3.3 of this AC. Manufacturers that have achieved compliance with such criteria shall provide this information in a letter to their customers, along with any operational limitation (for example, if the pilot must manually inhibit the use of facilities listed as unavailable in the NOTAM). The certification of the manufacturer may limit compliance to specific DME systems, or may reference any DME to TSO-C66c requirements. Manufacturers shall also provide a copy of the letter to the CAA.

(a) **FMS accuracy.-** FMS accuracy depends on a number of factors, including latent effects, the selection of DME facilities, the method of combining information from multiple DMEs, and the effects of other sensors used for positioning. For FMSs that use two or more DMEs at the same time and that limit the DME inclusion angle to between 30° and 150°, the precision requirement can be met if the DME sensors meet the precision requirements of TSO-C66c. For FMSs that lack these characteristics, precision shall be assessed under inadequate DME geometry scenarios and shall consider the demonstrated precision of the DME sensor. Inadequate geometry scenarios may include angles at the previously specified limits, with or without additional DME facilities available outside these conditions.

(b) **Identification of conditions.-** The conditions that might prevent compliance with precision requirements and the means to avoid them shall be identified.

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APPENDIX 2

CRITERIA FOR APPROVAL OF RNAV SYSTEMS THAT USE DME AND IRU

(DME/DME/IRU RNAV SYSTEM)

1. PURPOSE

This paragraph defines the minimum performance for the DME/DME/IRU (D/D/I) RNAV system. Performance standards for DME/DME positioning are detailed in Appendix 1. The minimum requirements set forth in Appendix 1 are applicable to this appendix and, thus, are not repeated, unless additional performance is required.

2. MINIMUM REQUIREMENTS FOR DME/DME/IRU RNAV SYSTEMS (INERTIAL SYSTEM PERFORMANCE)

Paragraph	Criteria	Explanation
a)	Inertial system performance must meet the criteria set forth in Appendix G to LAR 121 or equivalent.	
b)	Automatic position updating capability is required from the DME/DME solution.	***Note.-*** *Operators/pilots must contact manufacturers to discern if any annunciation of inertial coasting is suppressed following loss of radio updating.*
c)	Since some aircraft systems revert to VOR/DME-based navigation before reverting to inertial coasting, the impact of VOR radial accuracy when the VOR is greater than 40 NM from the aircraft, must not affect aircraft position accuracy.	A method to comply with this objective is to exclude from the RNAV system the VORs that are more than 40 NM away from the aircraft

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APPENDIX 3

FUNCTIONAL REQUIREMENTS – NAVIGATION FUNCTIONS AND DISPLAYS

Paragraph	Functional requirements	Explanation
a)	Navigation data, including the to/from indication and a failure indicator, must be shown on a lateral deviation display [*e.g.,* a course deviation indicator (CDI), an enhanced horizontal situation indicator (E)HSI) and/or a navigation chart display]. These lateral deviation displays will be used as primary means of navigation of the aircraft, for manoeuvre anticipation, and for indication of failure/status/integrity. They shall meet the following requirements:	Non-numeric lateral deviation displays (*e.g.*, CDI, (E)HSI), with to/from indication and failure warning, for use as primary means of navigation of the aircraft, manoeuvre anticipation, and indication of failure/status/integrity, with the following five attributes: 1) Displays will be visible to the pilot and will be located in the primary field of view (± 15 degrees from the normal line of sight of the pilot) when looking forward along the flight path; 2) The lateral deviation display scale must be consistent with all alerting and advisory limits, if implemented; 3) The lateral deviation display must also have a full-scale deflection suitable for the flight phase and must be based on the total system precision required; 4) The display scale may be automatically adjusted by default logic, or set to a value obtained from the navigation database. The full-scale deflection value must be known or must be available for display to the pilot, and must be consistent with the values for en-route, terminal, and approach operations; and 5) The lateral deviation display must be automatically slaved to the RNAV calculated path. The course selector of the lateral deviation display shall be automatically adjusted to the RNAV calculated path. ***Note.-*** *The normal functions of the stand-alone GNSS meet this requirement.* As an alternate means, a navigation chart display must provide a function equivalent to a lateral deviation display, as described in Paragraph a) 1) from (a) to (e), with appropriate chart scales; which may be manually adjusted by the pilot. ***Note.-*** *A number of modern aircraft eligible for this specification uses a chart display as an acceptable means to meet the prescribed requirements.*
b)	The following RNAV 1 and RNAV 2 system functions are required as a minimum:	1) The capability to continuously display to the pilot flying (PF), on the primary flight navigation instruments (primary navigation displays), the calculated desired RNAV path and the position of the aircraft relative to that path. For

Paragraph	Functional requirements	Explanation
		operations where the minimum flight crew is two pilots, means will be provided for the pilot not flying (PNF) the aircraft or monitoring pilot (MP) to check the desired path and the position of the aircraft relative to that path; 2) A navigation database containing current navigation data officially issued for civil aviation, which can be updated in accordance with the aeronautical information regulation and control (AIRAC) cycle and from which ATS routes can be retrieved and loaded into the RNAV system. The stored resolution of the data must be sufficient to achieve negligible path definition error (PDE). The database must be protected against flight crew modification of the stored data; 3) The means to display to the flight crew the period of validity of the navigation database; 4) The means to retrieve and display the data stored in the navigation database relating to individual waypoints and NAVAIDs, to enable the flight crew to verify the route to be flown; and 5) The capability to load on the RNAV system, from the navigation database, the complete RNAV segment of the SIDs or STARs to be flown. ***Note.-** Due to variability in RNAV systems, this document defines the RNAV segment from the first occurrence of a named WPT, track or course up to the last occurrence of a named WPT, track or course. Legs or segments prior to the first named WPT or after the last named WPT must not be loaded from the navigation database.*
c)	The means to show the following items, either on the primary field of view of the pilots, or on a readily accessible page display [*e.g.*, on a multi-function control display unit (MCDU)]:	1) The active navigation sensor type; 2) The identification to the active (TO) waypoint; 3) The ground speed or time to the active (TO) waypoint; and 4) The distance and bearing to the active (TO) waypoint. ***Note.-** When the CDU/MCDU is used to support precision checks by the pilot, said CDU/MCDU must have the capability of displaying lateral deviation with a resolution of at least 0.1 NM.*
d)	The capability to execute the "direct to" function.	
e)	The capability for automatic leg sequencing, displaying the sequence to the flight	

Paragraph	Functional requirements	Explanation
	crew.	
f)	The capability of executing ATS routes retrieved from the on-board database, including the capability of performing fly-by and flyover turns.	
g)	The aircraft must have the capability to automatically execute leg transitions and maintain tracks consistent with the following ARINC 424 path terminators or their equivalent: ➢ Initial fix (IF); ➢ Course to a fix (CF); ➢ Direct to a fix (DF); and ➢ Track to a fix (TF).	***Note 1.-*** *Path terminators are defined in ARINC 424 specification, and their application is described in more detail in RTCA documents DO-236B and DO-201A and in EUROCAE ED-75B and ED-77* ***Note 2.-*** *Numeric values for courses and tracks must be automatically loaded from the RNAV system database.*
h)	The aircraft must have the capability to automatically execute leg transitions consistent with the following ARINC 424 path terminators: heading to an altitude (VA), heading to a manual termination (VM), and heading to an intercept (VI), or must be capable of being manually flown on a heading to intercept a course or to fly direct to another fix after reaching an altitude of a specified procedure.	
i)	The aircraft must have the capability to automatically execute leg transitions consistent with the following ARINC 424 path terminators: course to an altitude (CA) and course from a fix to a manual termination (FM), or the RNAV system must permit the pilot to readily designate a waypoint and select a desired course to or from a designated waypoint.	
j)	The capability to load an	

Paragraph	Functional requirements	Explanation
	RNAV ATS route from the database into the RNAV system by its name is a recommended function. However, if all or part of an RNAV route (not SID or STAR) is entered by manual entry of WPTs from the database, the paths between the manual entry of WPTs and the preceding or subsequent WPTs must be flown in the same way as a TF leg in terminal airspace.	
k)	The capability of showing an indication of RNAV system failure, including the associated sensors, in the primary field of view of the pilots.	
l)	For multi-sensor systems, the capability for automatic reversion to an alternate RNAV sensor if the primary RNAV sensor fails. This does not preclude the provision of a means for manual selection of the navigation source.	
m)	Database integrity	Navigation database suppliers must comply with RTCA DO-200/EUROCAE document ED 76 - Standards for processing aeronautical data. A Letter of acceptance (LOA) issued by the appropriate regulatory authority to each of the participants in the data chain shows compliance with this requirement. Discrepancies that invalidate a route must be reported to database providers, and the affected routes must be prohibited through a notice from the operator to its flight crews. Aircraft operators must consider the need to conduct periodic checks of the navigation databases in order to meet the requirements of the existing safety system.
n)	It is recommended that the RNAV systems provide lateral guidance so that aircraft remain within the lateral boundaries of the fly-by transition area.	

APPENDIX 4

NAVIGATION DATA VALIDATION PROGRAMME

1. INTRODUCTION

The information stored in the navigation database defines the lateral and longitudinal guidance of the aircraft for RNAV1 and RNAV 2 operations. Navigation database updates are carried out every 28 days. The navigation data used in each update are critical to the integrity of every RNAV 1 and RNAV 2 route, SID, and STAR. This appendix provides guidance on operator procedures to validate the navigation data associated with the RNAV 1 and RNAV 2 operations.

2. DATA PROCESSING

a) The operator will identify in its procedures the person responsible for the navigation data updating process.

b) The operator must document a process for accepting, verifying, and loading navigation data into the aircraft.

c) The operator must place its documented data process under configuration control.

3. INITIAL DATA VALIDATION

3.1 The operator must validate every RNAV 1 and RNAV 2 route, SID and STAR before flying under instrument meteorological conditions (IMC) to ensure compatibility with the aircraft and to ensure that the resulting paths are consistent with the published routes, SIDs and STARs. As a minimum, the operator must:

a) compare the navigation data of RNAV 1 and RNAV 2 routes, SIDs, and STARs to be loaded into the FMS with valid charts and maps that contain the published routes, SIDs, and STARs.

b) validate the navigation data loaded for RNAV 1 and RNAV 2 routes, SIDs, and STARs, either on the flight simulator or on the aircraft, under visual meteorological conditions (VMC). RNAV 1 and RNAV 2 routes, SIDs, and STARs outlined on a chart display must be compared to the published routes, SIDs, and STARs. Complete RNAV 1 and RNAV 2 routes, SIDs, and STARs must be flown in order to ensure that the paths can be used, that they have no apparent lateral or longitudinal discrepancies, and that they are consistent with the published routes, SIDs, and STARs.

c) Once the RNAV 1 and RNAV 2 routes, SIDs, and STARs are validated, a copy of the validated navigation data shall be kept and maintained in order to compare them with subsequent data updates.

4. DATA UPDATING

After receiving a navigation data update and before using such data on the aircraft, the operator must compare the update with the validated routes. This comparison must identify and resolve any discrepancy in the navigation data. If there are significant changes (any change affecting route path or performance) in any part of a route and if those changes are verified through the initial data, the operator must validate the amended route in accordance with the initial validation data.

5. NAVEGATION DATA SUPPLIERS

Navigation data suppliers must have a letter of acceptance (LOA) in order to process these data (*e.g.*, FAA AC 20-153 or the document on the conditions for the issuance of letters of acceptance to navigation data providers by the European Aviation Safety Agency – EASA (EASA IR

21 Subpart G) or equivalent documents). A LOA recognises the data supplier as one whose data quality, integrity and quality management practices are consistent with the criteria set forth in document DO-200A/ED-76. The operator´s database supplier must have a Type 2 LOA and its respective suppliers must have a Type 1 or 2 LOA. The CAA may accept a LOA issued to navigation data suppliers or issue its own LOA.

6. AIRCRAFT MODIFICATIONS (DATABASE UPDATE)

If an aircraft system necessary for RNAV 1 and RNAV 2 operations is modified (*e.g.*, change of software), the operator is responsible for validating the RNAV 1 and RNAV 2 routes, SIDs, and STARs with the navigation database and the modified system. This can be done without any direct assessment if the manufacturer confirms that the modification has no effect on the navigation database or on path calculation. If there is no such confirmation by the manufacturer, the operator must perform an initial validation of the navigation data with the modified system.

APPENDIX 5

RNAV 1 and RNAV 2 APPROVAL PROCESS

a) The RNAV 1 and RNAV 2 approval process consists of two types of approvals, airworthiness and operational. Although the two have different requirements, they must be considered in one single process.

b) This process is an orderly method used by the CAA to make sure that the applicants meet the established requirements.

c) The approval process is made up by the following phases:

1)	Phase one:	Pre-application
2)	Phase two:	Formal application
3)	Phase three:	Documentation evaluation
4)	Phase four:	Inspection and demonstration
5)	Phase five:	Approval

d) In *Phase one - Pre-application*, the CAA calls the applicant or operator to a pre-application meeting. At this meeting, the CAA informs the applicant or operator of all the operational and airworthiness requirements that it must meet during the approval process, including the following:

1) the contents of the formal application;

2) the review and evaluation of the application by the aviation administration;

3) the limitations (if any) applicable to the approval; and

4) conditions under which the RNAV 1 and RNAV 2 approval could be cancelled.

e) In *Phase two – Formal Application*, the applicant or operator submits the formal application along with all the relevant documentation, as established in paragraph 9.1.1 b) of this CA.

f) In Phase three – *Documentation evaluation*, the CAA evaluates all the documentation and the navigation system to determine their eligibility and the approval method to be followed in connection with the aircraft. As a result of this analysis and evaluation, the CAA may accept or reject the formal application along with the documentation.

g) In *Phase four – Inspection and demonstration*, the operator will provide training to its personnel and will carry out the validation flight, if required.

h) In *Phase five* - Approval, the CAA issues the RNAV 1 and RNAV 2 approval once the operator has met the airworthiness and operational requirements. For LAR 121 and 135 operators, the CAA will issue the OpSpecs, and for LAR 91 operators, a LOA.

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APPENDIX 6

TRANSITION ROUTE TO RNAV 1 AND RNAV 2 OPERATIONS

a) The following steps identify the transition route to obtain RNAV 1 and RNAV 2 approval:

1) **Operators with no RNAV 1 and RNAV 2 approval.-** An operator wishing to operate in RNAV 1 and RNAV 2 designated airspace:

(a) must obtain the RNAV 1 and RNAV 2 approval based on this AC or equivalent document.

(b) An operator approved based on the criteria of this AC is eligible to operate in RNAV 1 and RNAV 2 routes in the United States and in European P-RNAV routes. No additional approval is required.

(c) An operator wishing to operate in P-RNAV designated airspace must obtain a P-RNAV approval in accordance with TGL-10.

2) **Operators with P-RNAV approval.-** An operator that maintains a P-RNAV approval according to TGL-10:

(a) is eligible to operate in the routes of any State where routes are based on TGL-10 criteria; and

(b) must obtain an RNAV 1 and RNAV 2 operational approval, with evidence of compliance with the differences that exist between TGL-10 and this AC or equivalent document, in order to operate in RNAV 1 and RNAV 2 designated airspace. This can be achieved by using Table 3-1.

Table 3-1 – Additional requirements to obtain an RNAV 1 and RNAV 2 approval based on a TGL-10 approval

Operator holding a TG-10 approval	**Needs to confirm the following RNAV 1 and RNAV 2 performance capabilities in connection with this CA**	**Notes**
If the approval includes use of DME/VOR equipment (the DME/VOR equipment may be used as the only positioning input where is explicitly allowed)	RNAV 1 does not include any DME/VOR RNAV-based route	RNAV system performance must be based on GNSS, DME/DME or DME/DME/IRU. However, DME/VOR input must not be inhibited or deselected
If approval includes use of DME/DME	No action is required if the RNAV system performance meets the specific navigation service criteria of this AC: DME/DME or DME/DME/IRU	The operator can ask the manufacturer or check the *FAA website for the system compliance list
RNAV SID specific requirement for with DME / DME aircraft	RNAV guidance available before reaching 500 ft above field elevation (AFE)	The operator must add this operational requirement
If approval includes use of GNSS	No action is required	

*http://www.faa.gov/about/office_org/headquarters_offices/avs/offices/afs/afs400/afs410/policy_guidace/

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APPENDIX C-2

RNAV 1 AND RNAV 2 JOB AID

APPLICATION TO CONDUCT RNAV 1 AND RNAV 2 OPERATIONS

RNAV 1 AND RNAV 2 JOB AID

APPLICATION TO CONDUCT RNAV 1 AND RNAV 2 OPERATIONS

1. Introduction

This Job Aid was developed by the Latin American Regional Safety Oversight Cooperation System (SRVSOP) to provide States, operators, and inspectors with guidance on the process to be followed by an operator in order to obtain an RNAV 1 and RNAV 2 authorization.

2. Purpose of the Job Aid

2.1 To give operators and inspectors information on the main RNAV 1 and RNAV 2 reference documents.

2.2 To provide tables showing the contents of the application, the associated reference paragraphs, the place in the application of the operator where RNAV 1 and RNAV 2 elements are mentioned and columns for inspector comments and follow-up on the status of various RNAV 1 and RNAV 2 elements.

3. Actions Recommended for the Inspector and Operator

Some recommendations for use of the Job Aid follow:

3.1 At the pre-application meeting with the operator, the inspector reviews the "basic events of the RNAV 1 and RNAV 2 approval process "described in Part 1 of this Job Aid, in order to provide an overview of the approval process events.

3.2 The inspector reviews this Job Aid with the operator in order to establish the form and content of the RNAV 1 and RNAV 2 approval application.

3.3 The operator uses this Job Aid as a guide to collect the documents/annexes of the RNAV 1 and RNAV 2 application.

3.4 The operator inserts in the Job Aid references showing in what part of its documents are the RNAV 1 and RNAV 2 programme elements located.

3.5 The operator submits the Job Aid and the application to the inspector (documents/annexes).

3.6 The inspector indicates in the Job Aid whether an item is in compliance or needs corrective action.

3.7 The inspector informs the operator as soon as possible when a corrective action by the operator is required.

3.8 The operator provides the inspector with the revised material when so requested.

3.9 The CAA provides the operator with the operational specifications (OpSpecs) or a letter of authorisation (LOA), as applicable, once the tasks and documents have been completed.

4. Structure of the Job Aid

5. Main sources of documents, information, and contacts

To access the RNAV 1 and RNAV 2 Job Aid, enter to the Web page of the ICAO/SAM Regional Office (www.lima.icao.int) under the SRVSOP link.

6. Main reference documents

Reference document	Title
Annex 6	Operation of aircraft
ICAO Doc 9613	Performance-based navigation (PBN) manual
FAA AC 90-100A	U.S. Terminal and en route area navigation (RNAV) operations
TGL 10	Airworthiness and operational approval for precision RNAV operations in designated European airspace
Spain DGAC CO 03/01	*Aprobaciones de aeronavegabilidad y operacionales para operaciones RNAV de precisión (P-RNAV) en el espacio aéreo Europeo designado*
AMC 20-5	Acceptable means of compliance for airworthiness approval and operational criteria for the use of the NAVSTAR Global positioning system (GPS)
AC 20-130()	Airworthiness approval of multi-sensor navigational system for use in the U.S. National Airspace System
AC 20-138A	Airworthiness approval of Global navigation satellite system (GNSS) equipment
AC 25-4	Inertial navigation system (INS)
AC 25-15	Approval of FMS in transport category airplanes
AC 90-45A	Approval of areas navigation systems for use in the U.S. National Airspace System

PART 1: GENERAL INFORMATION

Basic events in the RNAV 1 and RNAV 2 approval process

	Action by the operator	Action by the CAA
1	Establishes the need to obtain RNAV 1 and RNAV 2 authorization.	
2	Reviews the AFM, AFM supplement or Type Certificate Data Sheet (TCDS), or other appropriate documents (*e.g.,* service bulletins (SB), service letters (SL), etc.) to determine the eligibility of the aircraft for RNAV 1 and RNAV 2 operations. The operator contacts the aircraft or avionics manufacturer, if necessary, to confirm RNAV 1 and RNAV 2 or higher eligibility of the aircraft.	
3	Contacts the CAA to schedule a pre-application meeting to discuss the operational approval requirements.	
4		During the pre-application meeting, establishes: • the form and contents of the application; • the documents that support RNAV 1 and RNAV 2 approval • the date in which the application will be submitted for evaluation • if necessary, conducts a validation flight observed by the CAA
5	Submits the application at least 60 days before the start-up of RNAV 1 and RNAV 2 operations.	
6		Reviews the request of the operator.
7	Once the amendments to manuals, programmes, and documents have been approved, provides training to flight crews, flight dispatchers, and maintenance personnel, and conducts a validation flight, if required by the CAA.	Only if required, participates in the validation flight.
8		Once the operational and airworthiness requirements have been met, issues the operational approval in the form of OpSpecs for LAR 121 or 135 or equivalent operators, or an LOA for LAR 91 or equivalent operators, as appropriate.

Notes related to the approval process

1. **Responsible authority**

   a. **Commercial air transport (LAR 121 and/or 135 or equivalent regulations).-** The **State of Registry** determines that the aircraft meets the airworthiness requirements. The **State of the Operator** issues the RNAV 1 and RNAV 2 approval (*e.g.,* OpSpecs).

   b. **General Aviation (LAR 91 or equivalent regulations).-** The **State of Registry** determines that the aircraft meets the airworthiness requirements and issues the operational approval (*e.g.,* an LOA).

2. The CAA does not need to issue an LOA or an equivalent document for each individual area of operation in the case of LAR 91 operators.

3. LAR 121 and/or 135 operators with RNAV 1 and RNAV 2 approval must list this approval in the OpSpecs.

4. Related sections of the Latin American Aeronautical Regulations (LAR) or equivalent regulations

   a. LAR 91 Sections 91.1015 and 91.1640 or equivalents

   b. LAR 121 Section 121.995 (b) or equivalent

   c. LAR 135 Section 135.565 (c) or equivalent

5. Related ICAO Documents

   a. Annex 6 to the Convention on International Civil Aviation – Operation of Aircraft

   b. Annex 10 to the Convention on International Civil Aviation – Aeronautical Telecommunications

   c. Annex 15 to the Convention on International Civil Aviation – Aeronautical Information Services

   d. ICAO Doc 9613 – Manual on performance-based navigation (PBN)

   e. ICAO Doc 7030 – Regional supplementary procedures

PART 2: INFORMATION ON THE IDENTIFICATION OF AIRCRAFT AND OPERATORS

NAME OF THE OPERATOR: ____

Aircraft manufacturer, model, and series	Registration numbers	Serial numbers	Area navigation systems (RNAV) Number, manufacturer, and model	RNAV specification

DATE OF PRE-APPLICATION MEETING ____

DATE ON WHICH THE APPLICATION WAS RECEIVED ____

DATE ON WHICH THE OPERATOR INTENDS TO BEGIN RNAV 1 and RNAV 2 OPERATIONS ______________________

IS THE CAA NOTIFICATION DATE APPROPRIATE? YES _____ NO _____

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PART 3 – OPERATOR APPLICATION (ANNEXES AND DOCUMENTS)

Annex	Title of Annex/document	Indication of inclusion by the operator	Comments by the Inspector
A	**Operator letter requesting RNAV 1 and RNAV 2 authorization**		
B	**Airworthiness documents showing aircraft eligibility for RNAV 1 and RNAV 2** AFM, AFM revision, AFM supplement, or Type certificate data sheet (TCDS) showing that RNAV systems are eligible for RNAV 1 and RNAV 2 or RNP 1 or above. Statement by the manufacturer.- Aircraft that have a statement by the manufacturer documenting compliance with the criteria of SRVSOP CA 91-003 or equivalent meet the performance and functional requirements of said document.		
C	**Aircraft modified to meet RNAV 1 and RNAV 2 standards. Documentation on aircraft inspection and/or modification, if applicable.** Maintenance records documenting the installation or modification of aircraft systems (*e.g.,* FAA Form 337 – major repairs and alterations).		
D	**Maintenance programme** • For aircraft with established RNAV 1 and RNAV 2 system maintenance practices, the list of references of the document or programme. • For recently installed RNAV 1 and RNAV 2 systems, the maintenance practices for their review.		
E	**Minimum equipment list (MEL) (only for operators conducting operations based on a MEL):** MEL showing provisions for RNAV 1 and RNAV 2.		
F	**Training** **1. LAR 91 operators or equivalent: Training method:** Training at home, LAR		

	142 training centres, or other training courses, course completion records. **2. LAR 121 and/or 135 operators or equivalent:** Training programmes (training curriculums) for flight crews, flight dispatchers, and maintenance personnel.		
G	**Operating policies and procedures** **1. LAR 91 operators or equivalent:** Operations manual (OM) or sections to be attached to the application, corresponding to RNAV 1 and RNAV 2 operating procedures and policies. **2. LAR 121 and/or 135 operators or equivalent:** Operations manual and checklists.		
H	**Navigation database** Details of the navigation data validation programme.		
I	**Withdrawal of RNAV 1 and RNAV 2 approval** Indication of the need to follow up on navigation error reports submitted and the possibility of withdrawal of RNAV 1 and RNAV 2 approval.		
J	**Validation flight plan:** Only if required by the CAA**.**		

CONTENTS OF THE APPLICATION TO BE SUBMITTED BY THE OPERATOR

____ **DOCUMENTATION SHOWING RNAV 1 AND RNAV 2 COMPLIANCE BY AIRCRAFT/NAVIGATION SYSTEMS**

____ **OPERATING PROCEDURES AND POLICIES**

____ **SECTIONS OF THE MAINTENANCE MANUAL RELATED TO RNAV SYSTEMS (if not previously reviewed)**

Note 1: Documents may be grouped in a single folder or may be sent as individual documents.

PART 4: CONTENTS OF OPERATOR APPLICATION FOR RNAV 1 AND RNAV 2

#	Contents of the RNAV 1 and RNAV 2 application by the operator	Reference paragraphs CA 91-003	In what Annexes/Documents of the operator can the application contents be located Note: The operator must update this column to reflect the contents of the application	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
1	**Operator request letter** Statement of intent to obtain RNAV 1 and RNAV 2 authorization.	Paragraph 9.1.1 b) 1) Appendix 5, Paragraph e)	Annex A		
2	**Aircraft equipment description**	Paragraph 9.1.1 b) 2)			
3	**RNAV 1 and RNAV 2 systems eligibility** Airworthiness documents establishing the eligibility of RNAV navigation systems, their approval status, and a list of the aircraft for which the approval is being requested.	Paragraph 9.1.1 b) 3) Paragraph 8.3	Annex B Annex C		
4	**Training programmes** **1. LAR 121 or 135 operators or equivalent: Training programmes:** Operators will develop an initial and recurrent training programme for flight crews, flight dispatchers, if applicable, and	Paragraph 9.1.1 b) 4) (a) Paragraph 11 For maintenance Paragraph 9.1.1 b) 8)	Annex F		

#	Contents of the RNAV 1 and RNAV 2 application by the operator	Reference paragraphs CA 91-003	In what Annexes/Documents of the operator can the application contents be located Note: The operator must update this column to reflect the contents of the application	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
	maintenance personnel. **2. LAR 91 operators or equivalent: Training methods:** The following methods are acceptable for these operators: Training at home, LAR 142 training centres, or other training courses.	Paragraph 9.1.1 b) 4) (b) Paragraph 11			
5	**Operating procedures** **1. LAR 121 and/or 135 operators or equivalent:** Operations manual and checklists. **2. LAR 91 operators or equivalent:** Operations manual or section of the operator application documenting RNAV 1 and RNAV 2 policies and procedures.	Paragraph 9.1.1 b) 5) (a) Paragraph 10 Paragraph 9.1.1 b) 5) (b) Paragraph 10	Annex G		
6	**Maintenance practices** • For aircraft with established RNAV 1 and RNAV 2 maintenance practices, the operator will provide references of the documents.	Paragraph 8.5 b) Paragraph 9.1.1 b) 7)	Annex D		

#	Contents of the RNAV 1 and RNAV 2 application by the operator	Reference paragraphs CA 91-003	In what Annexes/Documents of the operator can the application contents be located Note: The operator must update this column to reflect the contents of the application	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
	• For newly installed RNAV 1 and RNAV 2 systems, the operator will provide maintenance practices for review.				
7	**Update of the minimum equipment list (MEL)** Applicable to operators conducting operations according to a MEL**.**	Paragraphs 8.5 a) and 9.1.1 b) 6)	Annex E		
8	**Navigation data validation programme**	Paragraph 9.1.1 b) 9)	Annex F		
9	**Withdrawal of RNAV 1 and RNAV 2 approval** Indication of the need for follow-up on the navigation error reports and the possibility of withdrawal of the RNAV 1 and RNAV 2 approval.	Paragraph 13	Annex H		
10	**Validation flight plan, only if required** The validation flight plan will be presented only if required.	Paragraph 9.1.1 d)	Annex I		

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PART 5 – GUIDE TO DETERMINE RNAV 1 AND RNAV 2 AIRCRAFT ELIGIBILITY

#	Topics	Reference paragraphs CA 91-003	Location in the Annexes of the operator	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
1	**RNAV system requirement** The RNAV system use inputs from the following types of sensors (not listed in a specific order of priority):	Paragraph 8.1.1	Annex B		
1a	GNSS according to TSO-C145 (), TSO-C146 () and TSO-C129()	Paragraph 8.1.1 a) 2) (a)			
1b	DME/DME	Paragraph 8.1.1 a) 2) (b)			
1c	DME/DME/IRU	Paragraph 8.1.1 a) 2) (c)			
2	**Performance, monitoring and alerting requirements**	Paragraph 8.1.2	Annex B		
3	**Aircraft eligibility** 1. Aircraft that have a statement of compliance with SRVSOP CA 91-003 criteria. 2. Aircraft approved under TGL-10 and AC 90-100A. 3. Aircraft that meet TGL-10. 4. Aircraft that comply with AC 90-100A.	Paragraph 8.2 Paragraph 8.2.1 Paragraph 8.2.2 Paragraph 8.2.3	Annex B		

#	Topics	Reference paragraphs CA 91-003	Location in the Annexes of the operator	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
	5. Aircraft with a statement by the manufacturer. 6. Information to be included in the AFM, POH or avionics operating manual	Paragraph 8.2.4 Paragraph 8.2.5 Paragraph 8.2.6			
4	**Criteria for RNAV 1 and RNAV 2 systems**	Paragraph 8.3	Annex B		
4a	GNSS RNAV system	Paragraph 8.3.1	Annex B		
4b	DME/DME RNAV system	Paragraph 8.3.2 Appendix 1 Paragraph 2	Annex B		
4c	Confirmation of the performance of RNAV systems that use DME	Paragraph 8.3.3 Appendix 1 Paragraph 3	Annex B		
4d	DME/DME/IRU RNAV system	Paragraph 8.3.4 Appendix 2 Paragraph 2	Annex B		
5	**Functional requirements and their explanation**	Paragraph 8.4 Appendix 3	Annex B		
6	**Maintenance requirements**	Paragraph 8.5	Annex B		
7	**Navigation database** Details of the navigation data validation programme.	Paragraph 12 Appendix 4	Annex B		

PART 6 - BASIC PILOT PROCEDURES FOR RNAV 1 AND RNAV 2 OPERATIONS

Topics		Reference paragraphs CA 91-003	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
Operating procedures		Paragraph 10	Annex G		
1	**Pre-flight planning**	Paragraph 10.1 a)			
	Operators and pilots intending to conduct RNAV 1 and RNAV 2 operations must fill in the appropriate boxes of the ICAO flight plan.	Paragraph 10.1 a) 1)			
	On-board navigation data must be current and be appropriate for the intended operating region, and will include NAVAIDS, WPTs, and the relevant ATS route codes for departures, arrivals and alternate aerodromes. RNAV STAR procedures may be designated using multiple runway transitions. Operators that do not have this function will provide an alternate means of compliance (for example, a navigation database adjusted to these operations). If there is no alternate means of compliance to fly an RNAV procedure containing multiple runway transitions, the operators will not submit or accept an approval for these procedures.	Paragraph 10.1 a) 2)			
	Using all the information available, the availability of the required navigation infrastructure for the projected routes, including any non-RNAV contingency, must be confirmed for the foreseen period of operation. Since Annex 10 Volume I requires GNSS (RAIM or SBAS) integrity, it must be determined that the availability of these devices	Paragraph 10.1 a) 3)			

	Topics	Reference paragraphs CA 91-003	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	is also appropriate.				
	Aircraft not equipped with GNSS.- Aircraft not equipped with GNSS must be capable of updating the DME/DME and DME/DME/IRU position for RNAV 1 and RNAV 2 routes, as well as for SIDs and STARs.	Paragraph 10.1 a) 4)			
	If only the TSO-C129 equipment is used to meet RNAV 1 and RNAV 2 requirements, RAIM availability for the intended route of flight (route and time) must be confirmed using current GNSS satellite information.	Paragraph 10.1 a) 5)			
	If TSO-C145/C146 equipment is used to meet the RNAV requirement, the pilot/operator does not need to do the prediction if it is confirmed that the coverage of the wide area augmentation system (WAAS) will be available throughout the flight route.	Paragraph 10.1 a) 6)			
	Availability of RAIM (ABAS)	Paragraph 10.1 a) 7)			
	Availability of DME	Paragraph 10.1 a) 8)			
2	**General operating procedures**	Paragraph 10.1 b)			
	Operators and pilots shall not request, or present in the flight plan, RNAV 1 and RNAV 2 routes, SIDs or STARs, unless they meet all the CA 91-003 criteria. If an aircraft that does not meet these criteria receives an authorisation from the	Paragraph 10.1 b) 1)			

	Topics	Reference paragraphs CA 91-003	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	ATC to conduct an RNAV procedure, the pilot will notify the ATC that it cannot accept the authorisation and will request alternate instructions;				
	The pilot shall follow any instruction or procedure identified by the manufacturer, as necessary, to meet the performance requirements of this section;	Paragraph 10.1 b) 2)			
	At system initialization, pilots must: (a) confirm the validity of the navigation database; (b) verify the current position of the aircraft; (c) verify the proper entry of the assigned ATC route once the initial clearance is received, and of any subsequent route changes; and (d) ensure that the WPT sequence displayed on the navigation system coincides with the route shown in the appropriate charts and with the assigned route.	Paragraph 10.1 b) 3)			
	Pilots shall not fly an RNAV 1 or RNAV 2 SID or STAR unless it can be retrieved from the on-board navigation database using the procedure name and is consistent with the procedure in the chart. However, the route can be modified afterwards by inserting or deleting specific WPTs based on an ATC clearance. Manual entry or the creation of new WPTs by manually entering latitude and longitude or rho/theta values is not allowed.	Paragraph 10.1 b) 4)			

Topics		Reference paragraphs CA 91-003	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	Furthermore, pilots must not change an RNAV SID or STAR WPT from a fly-by WPT to a flyover WPT or *vice versa*.				
	Whenever possible, RNAV 1 or RNAV 2 routes must be obtained from the database as a whole, instead of loading route WPTs individually from the database to the flight plan. However, designated WPTs and fixes can be individually selected and inserted from the navigation database provided all the fixes along the published route to be flown are inserted. Furthermore, the route can be modified afterwards by inserting or deleting specific WPTs based on ATC clearances. Manual entry or the creation of new WPTs by manually entering latitude and longitude or rho/theta values is not allowed.	Paragraph 10.1 b) 5)			
	Flight crews must verify the cleared flight plan by comparing the charts or other applicable resources to the navigation system text displays and aircraft chart displays, as applicable. If required, the exclusion of specific NAVAIDs must be confirmed. A procedure must not be used if there is any doubt about the validity of the procedure in the navigation database.	Paragraph 10.1 b) 6)			
	During the flight, when feasible, the flight crew must use the information available from ground NAVAIDs to confirm that navigation is reasonable.	Paragraph 10.1 b) 7)			
	For RNAV 2 routes, pilots must use a lateral deviation indicator, an FD or an AP in lateral navigation mode. Pilots may use a navigation chart	Paragraph 10.1 b) 8)			

Topics		Reference paragraphs CA 91-003	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	display with a functionality equivalent to a lateral deviation indicator without an FD or AP.				
	For RNAV 1 routes, pilots must use a lateral deviation indicator, an FE or an AP in the lateral navigation mode.	Paragraph 10.1 b) 9)			
	Pilots of aircraft with lateral deviation display must make sure that the lateral deviation scale is appropriate for the navigation precision associated to the route/procedure (*e.g.*, full-scale deflection: ± 1 NM for RNAV 1, ± 2 NM for RNAV 2 o ± 5 NM for TSO-C129() equipment in RNAV 2 routes.	Paragraph 10.1 b) 10)			
	All pilots are expected to maintain the route centrelines represented on the on-board lateral deviation indicators and/or flight guide during all RNAV 1 and RNAV 2 operations, unless cleared by the ATC to deviate or in response to an emergency. For normal operations, the cross-track error/deviation (the difference between the path calculated by the RNAV system and the position of the aircraft relative to the path) shall not exceed ± ½ the navigation precision associated to the route or flight procedure (*e.g.*, 0.5 NM for RNAV 1 and 1.0 NM for RNAV 2). Small lateral deviations from this requirement are allowed (*e.g.,* overshooting or undershooting the path) during or immediately after an en-route turn/procedure, up to a maximum of 1 times the navigation precision (1xRNP) (*e.g.,* 1 NM for RNAV 1 and 2 NM for RNAV 2).	Paragraph 10.1 b) 11)			
	If the ATC assigns a course that places the aircraft	Paragraph 10.1 b)			

	Topics	Reference paragraphs CA 91-003	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	outside the route, the pilot shall not modify the flight plan in the RNAV system, until a new clearance is received that allows the aircraft to resume the route or the controller confirms a new route clearance. When the aircraft if not in the published route, the specified precision requirements do not apply.	12)			
	Manual selection of functions that limit the bank angle of the aircraft may reduce the ability of the aircraft to maintain its desired track and is not recommended. Pilots should recognise that manual selection of functions that limit the bank angle of the aircraft could reduce its ability to meet ATC path expectations.	Paragraph 10.1 b) 13)			
	Pilots operating aircraft with RNP approval according to the CA 91-003 provisions do not need to modify the pre-determined RNP values of the manufacturer, as established in the FMC.	Paragraph 10.1 b) 14)			
3	**Specific RNAV SID requirements**	Paragraph 10.1 c)			
	Prior to commencing take-off, the pilot must verify that the RNAV system of the aircraft is available, is operating properly, and that the appropriate aerodrome and runway data have been loaded. Before the flight, pilots must verify that the navigation system of the aircraft is operating properly and that the appropriate departure procedure (including any applicable en-route transition) has been entered and is duly displayed. Pilots assigned to an RNAV departure procedure and subsequently receive a change of runway,	Paragraph 10.1 c) 1)			

	Topics	Reference paragraphs CA 91-003	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	procedure or transition, must verify that the appropriate changes have been entered and are available for navigation before take-off. A final check of proper runway entry and correct route depiction, shortly before take-off, is recommended.				
	RNAV equipment engagement altitude.- The pilot must be able to connect the RNAV equipment in order to follow the flight guide in the RNAV lateral navigation mode before reaching 153 m (500 ft) over the aerodrome elevation. The altitude at which the RNAV guide starts in a given route can be higher (*e.g.*, climb to 304 m (1 000 ft) then straight to…)	Paragraph 10.1 c) 2)			
	Pilots must use an authorised method (lateral deviation indicator/navigation map display/FD/AP) to reach an appropriate level of performance for RNAV 1.	Paragraph 10.1 c) 3)			
	DME/DME aircraft.- Pilots of aircraft without GNSS, that use DME/DME sensors without inertial input, cannot use their RNAV systems until the aircraft has entered the appropriate DME coverage. The ANSP will make sure that there is appropriate DME coverage available in each RNAV SID (DME/DME).	Paragraph 10.1 c) 4)			
	DME/DME/IRU aircraft.- Pilots or aircraft without GNSS, that use DME/DME RNAV systems with an IRU (DME/DME/IRU), must make sure that the position of the inertial navigation system (INS) is confirmed within 304 m (1 000 ft/0.17 NM), from a know position, at the starting point of the take-off	Paragraph 10.1 c) 5)			

Topics		Reference paragraphs CA 91-003	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	roll. This is usually achieved by using a manual or automatic runway update function. A navigation chart can also be used to confirm the position of the aircraft, if the pilot procedures and display resolution permit compliance with the 304 m (1 000 ft) tolerance requirement.				
	GNSS aircraft.- When a GNSS is used, the signal must be obtained before commencing the take-off roll. For aircraft using TSO-C129/C129a equipment, the take-off aerodrome must be loaded in the flight plan in order to achieve the appropriate navigation system monitoring and sensitivity. For aircraft using TSO-C145a/C146a avionics, if the departure begins at a runway waypoint, then the departure airport does not need to be in the flight plan to obtain appropriate monitoring and sensibility.	Paragraph 10.1 c) 6)			
4	**Specific RNAV STAR requirements**	Paragraph 10.1 d)			
	Before the arrival phase, the flight crew must check that the correct terminal route has been loaded. The active flight plan shall be checked, by comparing the charts to the map display (if applicable) and the MCDU. This includes confirmation of WPT sequence, the reasonableness of track angles and distances, any altitude or speed restriction, and, when feasible, which are fly-by WPTs and which are flyover WPTs. If the route so requires, a check must be done to confirm that the update will exclude a particular NAVAID. A route will not be used if there is any doubt about its validity in the navigation	Paragraph 10.1 d) 1)			

	Topics	Reference paragraphs CA 91-003	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	database.				
	The creation of new WPTs by the flight crew through manual entry in the RNAV system will invalidate any route and is not allowed.	Paragraph 10.1 d) 2)			
	Where contingency procedures require reversion to a conventional arrival route, the flight crew must complete the necesary preparations before commencing the RNAV route.	Paragraph 10.1 d) 3)			
	Route modifications in the terminal area may take the form of radar headings or “direct to” clearances. In this regard, the flight crew must be capable of reacting in time. This may include entering tactical WPTs from the database. The flight crew is not allowed to enter manually or modify a loaded route using provisional WPTs or fixes not provided in the database.	Paragraph 10.1 d) 4)			
	Pilots must verify that the aircraft navigation system is operating properly and the correct arrival procedure and runway are properly entered and depicted.	Paragraph 10.1 d) 5)			
	Although no particular method is mandated, any publish altitude and speed constraints must be observed.	Paragraph 10.1 d) 6)			
5	**Contingency procedures**	Paragraph 10.1 e)			
	The pilot must notify the ATC of any loss of RNAV capability, and the proposed course of action. If the	Paragraph 10.1 e) 1)			

Topics		Reference paragraphs CA 91-003	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	requirements of an RNAV route cannot be met, pilots must notify the ATS as soon as possible. Loss of RNAV capability includes any failure or event that causes the aircraft to be unable to meet the RNAV requirements of the route.				
	In case of a communication failure, the flight crew must continue with the RNAV route, in accordance with the procedure established for lost communications.	Paragraph 10.1 e) 2)			

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Job Aid RNAV 1 and RNAV 2
Version: Original
Date: 12/10/2009

APPENDIX D-1

ADVISORY CIRCULAR

AC	**:**	**91-006**
DATE	**:**	**12/10/09**
REVISION	**:**	**Original**
ISSUED BY	**:**	**SRVSOP**

SUBJECT: AIRCRAFT AND OPERATOR APPROVAL FOR BASIC-RNP 1 OPERATIONS

ADVISORY CIRCULAR

AC	**:**	**91-006**
DATE	**:**	**12/10/09**
REVISION	**:**	**Original**
ISSUED BY	**:**	**SRVSOP**

SUBJECT: AIRCRAFT AND OPERATOR APPROVAL FOR BASIC-RNP 1 OPERATIONS

1. PURPOSE

This Advisory Circular (AC) establishes Basic-RNP 1 approval requirements for aircraft and operators.

An operator may use alternate means of compliance, provided those means are acceptable to the Civil Aviation Administration (CAA).

The future tense of the verb or the term "shall" apply to operators who choose to meet the criteria set forth in this CA.

2. RELEVANT SECTIONS OF THE LATIN AMERICAN AERONAUTICAL REGULATIONS (LAR) OR EQUIVALENT

LAR 91: Sections 91.1015 and 91.1640 or equivalents

LAR 121: Section 121.995 (b) or equivalent

LAR 135: Section 135.565 (c) or equivalent

3. RELATED DOCUMENTS

Annex 6	Operation of aircraft
	Part I – International commercial air transport – Aeroplanes
	Part II – International general aviation - Aeroplanes
Annex 10	Aeronautical communications
	Volume I: Radio navigation aids
Annex 15	Aeronautical information services
ICAO Doc 9613	Performance based navigation (PBN) manual
ICAO Doc 4444	Procedures for air navigation services – Air traffic management (PANS-ATM)
ICAO Doc 8168	Aircraft operations
	Volume I: Flight procedures
	Volume II: Construction of visual and instrument flight procedures
FAA AC 90-105 Appendix 2	Qualification criteria for RNP 1 (terminal) operations

4. DEFINITIONS AND ABBREVIATIONS

4.1 Definitions

a) **Aircraft-based augmentation system (ABAS).-** A system which augments and/or integrates the information obtained from the other GNSS elements with information available on board the aircraft. The most common form of ABAS is the receiver autonomous integrity monitoring (RAIM).

b) **Area navigation (RNAV)**.- A navigation method that allows aircraft to operate on any desired flight path within the coverage of ground- or space-based navigation aids, or within the limits of the capability of self-contained aids, or a combination of both methods.

Area navigation includes performance-based navigation as well as other operations that are not contemplated in the definition of performance-based navigation.

c) **Flight technical error (FTE)**.- The FTE is the accuracy with which an aircraft is controlled as measured by the indicated aircraft position with respect to the indicated command or desired position. It does not include blunder errors.

d) **Global navigation satellite system (GNSS)**.- A generic term used by the International Civil Aviation Organization (ICAO) to define any global position, speed, and time determination system that includes one or more main satellite constellations, such as GPS and the global navigation satellite system (GLONASS), aircraft receivers and several integrity monitoring systems, including aircraft-based augmentation systems (ABAS), satellite-based augmentation systems (SBAS), such as the wide area augmentation systems (WAAS), and ground-based augmentation systems (GBAS), such as the local area augmentation system (LAAS).

Distance information will be provided, at least in the immediate future, by GPS and GLONASS.

e) **Global positioning system (GPS)**.- The global positioning system (GNSS) of the United States is a satellite-based radio navigation system that uses precise distance measurements to determine the position, speed, and time in any part of the world. The GPS is made up by three elements: the spatial, the control, and the user elements. The GPS spatial segment nominally consists of, at least, 24 satellites in 6 orbital planes. The control element consists of 5 monitoring stations, 3 ground antennas, and one main control station. The user element consists of antennas and receivers that provide the user with position, speed, and precise time.

f) **Navigation specifications**.- Set of aircraft and flight crew requirements needed to support performance-based navigation operations in a defined airspace. There are two kinds of navigation specifications:

Required Navigation Performance (RNP) Specification.- Area navigation specification that includes the performance control and alerting requirement, designated by the prefix RNP; *e.g.,* RNP 4, RNP APCH, RNP AR APCH.

Area Navigation (RNAV) Specification.- Area navigation specification that does not include the performance control and alerting requirement, designated by the prefix RNAV; *e.g*., RNAV 5, RNAV 2, RNAV 1.

Note 1.- *The Manual on Performance-based Navigation (PBN) (Doc 9613), Volume II, contains detailed guidelines on navigation specifications.*

Note 2.- *The term RNP, formerly defined as "a statement of the navigation performance necessary for operation within a defined airspace", has been deleted from the Annexes to the Convention on International Civil Aviation because the RNP concept has been replaced by the PBN concept. In said Annexes, the term RNP is now only used within the context of the navigation specifications that require on-board performance control and alerting; e.g., RNP 4 refers to the aircraft and the operational requirements, including a lateral performance of 4 nautical miles (NM), with the requirement for on-board performance control and alerting as described in the PBN Manual of the International Civil Aviation Organization (ICAO) (Doc 9613).*

g) **Navigation system error (NSE).-** The difference between the true position and the estimated position.

h) **Path definition error (PDE).-** The difference between the defined path and the desired path at a given place and time.

i) **Performance-based navigation (PBN)**.- Performance-based area navigation requirements applicable to aircraft conducting operations on an ATS route, on an instrument approach procedure, or in a designated airspace.

Performance requirements are expressed in navigation specifications (RNAV and RNP specifications) in terms of the precision, integrity, continuity, availability, and functionality necessary to perform the proposed operation within the context of a particular airspace concept.

j) **Receiver autonomous integrity monitoring (RAIM)**.- A technique used in a GPS receiver/processor to determine the integrity of its navigation signals, using only GPS signals or GPS signals enhanced with barometric altitude data. This determination is achieved by a consistency check between redundant pseudo-range measurements. At least one additional available satellite is required with respect to the number of satellites that are needed for the navigation solution.

k) **RNP operations**.- Aircraft operations that use an RNP system for RNP applications.

l) **RNP system**.- An area navigation system that supports on-board performance control and alerting.

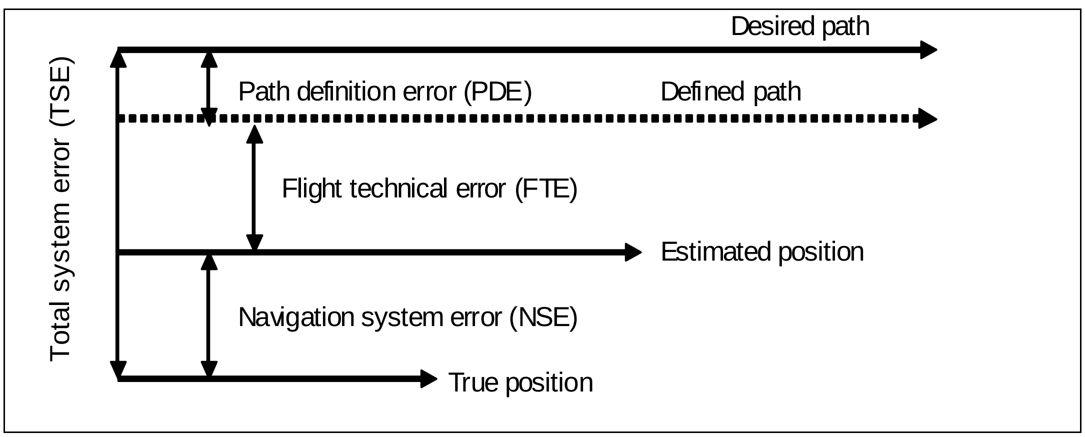
m) **Standard instrument arrival (STAR)**.- A designated instrument flight rule (IFR) arrival route linking a significant point, normally on an air traffic service (ATS) route, with a point from which a published instrument approach procedure can be commenced.

n) **Standard instrument departure (SID)**.- A designated instrument flight rule (IFR) departure route linking the aerodrome or a specified runway of the aerodrome with a specified significant point, normally on a designated ATS route, at which the en-route phase of a flight commences.

o) **Total system error (TSE).-** The difference between the true position and the desired position. This error is equal to the sum of the vectors of the path definition error (PDE), the flight technical error (FTE), and the navigation system error (NSE).

Note.- *On occasions, the FTE is known as path steering error (PSE), and the NSE as position estimation error (PEE).*

Total system error (TSE)



a) **Way-point (WPT).** A specified geographical location used to define an area navigation route or the flight path of an aircraft employing area navigation. Way-points area identified as either:

Fly-by way-point.- A way-point which requires turn anticipation to allow tangential interception of the next segment of a route or procedure.

Fly over way-point.- A way-point at which a turn is initiated in order to join the next segment of a route or procedure.

4.2 Abbreviations

a) AAC Civil Aviation Administration/Civil Aviation Authority

b)	ABAS	Aircraft-based augmentation system
c)	AC	Advisory circular (FAA)
d)	AFM	Aircraft flight manual
e)	VM	Heading of the aircraft to a normal termination
f)	AIP	Aeronautical information publication
g)	AIRAC	Aeronautical information regulation and control
h)	ANSP	Air navigation service providers
i)	AP	Automatic pilot
j)	APV	Approach procedure with vertical guidance
k)	ARP	Aerodrome reference point
l)	ATC	Air traffic control
m)	ATM	Air traffic management
n)	ATS	Air traffic service
o)	baro-VNAV	Barometric vertical navigation
p)	CA	Advisory circular (SRVSOP)
q)	CA	Course to an altitude
r)	CDI	Course deviation indicator
s)	CDU	Control display
t)	CF	Course to a fix
u)	Doc	Document
v)	DF	Direct to a fix
w)	DME	Distance-measuring equipment
x)	DV	Flight dispatcher
y)	EASA	*Agencia Europea de Seguridad Aérea* (European Air Safety Agency)
z)	EHSI	Enhanced vertical status indicator
aa)	FAA	United States Federal Aviation Administration
bb)	FAF	Final approach fix
cc)	FAP	Final approach point
dd)	FD	Flight director
ee)	FM	Course from a fix to a manual termination
ff)	Fly-by WPT	Fly-by way-point
gg)	Flyover WPT	Flyover way-point
hh)	FMS	Flight management system
ii)	FTE	Flight technical error
jj)	GBAS	Ground-based augmentation system
kk)	GNSS	Global navigation satellite system

ll)	GLONASS	Global navigation satellite system
mm)	GPS	Global positioning system
nn)	GS	Ground speed
oo)	HAL	Horizontal alerting limit
pp)	HSI	Vertical status indicator
qq)	IF	Initial fix
rr)	IFR	Instrument flight rules
ss)	IMC	Instrument meteorological conditions
tt)	LAAS	Local area augmentation system
uu)	LAR	Latin American Aeronautical Regulations
vv)	LNAV	Lateral navigation
ww)	LOA	Letter of authorisation/letter of acceptance
xx)	MCDU	Multi-function control display
yy)	MEL	Minimum equipment list
zz)	MIO	Manual of the operations inspector
aaa)	NM	Nautical miles
bbb)	MP	Monitoring pilot
ccc)	NAVAIDS	Navigation aids
ddd)	NOTAM	Notice to airmen
eee)	NPA	Non-precision approach
fff)	NSE	Navigation system error
ggg)	LNAV	Lateral navigation
hhh)	OACI	International Civil Aviation Organization
iii)	OM	Operations manual
jjj)	OEM	Original equipment manufacturer
kkk)	OpSpecs	Operations specifications
lll)	PA	Precision approach
mmm)	PANS-ATM	Procedures for Air Navigation Services - Air traffic management
nnn)	PANS-OPS	Procedures for Air Navigation Services - Aircraft Operations
ooo)	PBN	Performance-based navigation
ppp)	PDE	Path definition error
qqq)	PEE	Position estimation error
rrr)	PF	Pilot flying
sss)	PNF	Pilot not flying
ttt)	POH	Pilot operations handbook
uuu)	P-RNAV	Precision area navigation
vvv)	PSE	Path direction error

www) RAIM Receiver autonomous integrity monitoring

xxx) RNAV Area navigation

yyy) RNP Required navigation performance

zzz) RNP APCH Required navigation performance approach

aaaa) RNP AR APCH Required navigation performance authorisation required approach

bbbb) RTCA Radio Technical Commission for Aviation

cccc) SBAS Satellite-based augmentation system

dddd) SID Standard instrument departure

eeee) SRVSOP Regional Safety Oversight Cooperation System l

ffff) STAR Standard instrument arrival

gggg) STC Supplementary type certificate

hhhh) TF Track to a fix

iiii) TO/FROM To/from

jjjj) TSE Total system error

kkkk) TSO Technical standard order

llll) VA Heading to a given altitude

mmmm) VI Heading to an intercept

nnnn) VM Heading to a normal termination

oooo) VMC Visual meteorological conditions

pppp) WAAS Wide area augmentation system

qqqq) WGS World geodetic system

rrrr) WPT Waypoint

5. INTRODUCTION

5.1 According to Doc 8168 – Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS) Volume II, the Basic-RNP 1 navigation specification is used in standard instrument departures and arrivals (SIDs and STARs) and in approaches to the final approach fix (FAF)/final approach point (FAP) with or without air traffic service (ATS) surveillance.

5.2 This AC does not establish all the requirements that may be specified for a given operation. These requirements are established in other documents, such as the aeronautical information publication (AIP) and ICAO Doc 7030 – Regional Supplementary Procedures.

5.3 Although the operational approval is normally related to airspace requirements, the operators and flight crews must consider the operational documents required by the CAA before conducting flights in Basic-RNP 1 airspace.

5.4 The material described in this CA has been developed based on the following document:

- ✓ ICAO Doc 9613, Volume II, Part C, Chapter 3 – Implementing Basic-RNP 1.

5.5 To the extent possible, this CA has been harmonised with the following guidance material:

- ✓ FAA AC 90-105 Appendix 2 - Qualification criteria for RNP 1 (terminal) operations

Note.- *Despite harmonisation efforts, operators shall take note of the differences between this CA and the aforementioned document when applying for an approval from the corresponding Administration.*

6. GENERAL CONSIDERATIONS

6.1 General information

a) **Performance-based navigation concept.-** The performance-based navigation (PBN) concept represents a change from sensor-based navigation to PBN. The PBN concept specifies the performance requirements of the aircraft RNP system in terms of the precision, integrity, availability, continuity, and functionality required for operations in a given airspace. Performance requirements are identified in the navigation specifications (*e.g.*, the requirements of this AC), which also identify options in terms of navigation sensors, navigation equipment, operating procedures, and training needs to meet performance requirements.

b) RNP procedures and routes require the use of RNP systems with onboard performance monitoring and alerting. A critical component of RNP is the ability that must have the aircraft navigation systems in combination with the pilot to monitor its achieved navigation performance, and to identify for the pilot whether the operational requirement is or is not met during an operation.

Note.- *Compliance with the performance control and alerting requirements does not imply automatic monitoring of the flight technical error (FTE). The on-board performance monitoring and alerting function should consist at least of a navigation system error (NSE) monitoring and alerting algorithm and a lateral navigation display that allow the flight crew to monitor the FTE. To the extent operational procedures are used to control the FTE, the flight crew procedures, equipment characteristics and the facilities are assessed for effectiveness and equivalence, as described in the functional requirements and operating procedures. The path definition error (PDE) is considered negligible due to the quality assurance process and crew procedures.*

c) **Operations with RNP systems**.- RNP operations:

1) do not require the pilot to monitor the ground-based navigation aids (NAVAIDs) used for position updating, unless required by the aircraft flight manual (AFM);

2) base obstacle clearance assessments on the associated required system performance;

3) Rely on conventional compliance with descent profiles and altitude requirements;

Note.- *Pilots operating aircraft with an approved barometric vertical navigation (baro-VNAV) system can continue using said system while operating on routes SIDs, and STARs. Operators must ensure compliance with all altitude limitations as published in the procedure in reference to the pressure altimeter.*

4) all routes and procedures must be based on the world geodetic system (WGS) of coordinates 84; and

5) the navigation data published for the routes, procedures and supporting NAVAIDs must meet the requirements of Annex 15 to the Convention on International Civil Aviation.

6.2 Navigation aid infrastructure

a) The GNSS is the main navigation system that supports Basic-RNP 1 operations.

b) Although RNP systems based on DME/DME are capable of providing Basic-RNP 1 accuracy, the use of this navigation specification has been foreseen mainly for environments where DME infrastructure cannot support DME/DME area navigation with the required performance.

c) The increased complexity in the DME infrastructure requirements and assessment make Basic-RNP 1 operations based on DME/DME impractical and unprofitable for a general application.

d) Route design should take into account the navigation performance that can be achieved with the available navigation aid (NAVAID) infrastructure. Although the requirements of RNAV 1 and RNAV 2 navigation systems are identical, NAVAID infrastructure can affect the required performance.

e) Air navigation service providers (ANSPs) shall ensure that the operators of GNSS equipped aircraft have a means available to predict fault detection using an aircraft-based augmentation system (ABAS) [*e.g*., receiver autonomous integrity monitoring (RAIM)].

f) When applicable, the ANSPs shall also ensure that the operators of aircraft equipped with a satellite-based augmentation system (SBAS) have a means to predict fault detection.

g) The prediction services may be provided by the ANSP, airborne equipment manufacturers other entities.

h) Prediction services can only be for receivers that meet the minimum performance of a technical standard order (TSO) or be specific to the receiver design. The prediction service shall use status information on GNSS satellites and a horizontal alerting limit (HAL) appropriate for the operation (1 NM within 30 NM from the aerodrome and 2 NM otherwise).

i) Outages shall be identified in the event of a predicted, continuous loss of ABAS fault detection of more than 5 minutes for any part of the Basic-RNP 1 operation.

j) ANSPs must undertake an assessment of the NAVAIDS infrastructure. It must be demonstrated that the assessment is sufficient for the proposed operations, including reversionary modes.

6.3 **Communications and ATS surveillance**

a) The Basic-RNP 1 navigation specification is intended in environments where ATS surveillance is limited or not available.

b) Basic-RNP 1 SIDs and STARs are primary intended to be conducted in direct controller-pilot communication environments.

6.4 **Obstacle clearance and horizontal separation**

a) Doc 8168 (PANS OPS), Volume II, provides detailed guidance on obstacle clearance. The general criteria contained in Parts I and III of said document shall apply.

b) The obstacle clearance criteria for SIDs, STARs, initial and intermediate approach, final missed approach, holding pattern, and route of the basic RNP 1 navigation specification are described in Doc 8168 (PANS-OPS), Volume II, Part III, Section 1, Chapter 2 and Section 3, Chapters 1, 2, 7 and 8.

c) Obstacle clearance criteria for final approach and for initial and intermediate missed approach are specific to the classification of non-precision approaches (NPA), approaches with vertical guidance (APV) and precision approaches (PA).

d) En-route spacing for basic RNP 1 depends on route configuration, air traffic density, and intervention capacity. Horizontal separation standards are published in Doc 4444 – Procedures for air navigation services – Air traffic management (PANS-ATM).

6.5 **Publications**

a) SIDs, STARs and Basic-RNP 1 procedures must be based on normal descent profiles and must identify minimum altitude requirements of the segments.

b) The navigation information published in the AIP for support procedures and NAVAIDs must meet the requirements of Annex 15 - Aeronautical information services.

c) All procedures must be based on the coordinates of the world geodetic system - 84 (WGS-84).

d) The AIP should clearly indicate whether the navigation application is Basic-RNP 1.

e) The available navigation infrastructure shall be clearly designated in all the appropriate charts (*e.g.*, GNSS).

f) The required navigation standard (*e.g.*, Basic-RNP 1) for all Basic-RNP 1 procedures shall be clearly designated in all the appropriate charts.

6.6 **Additional considerations**

a) For procedure design and infrastructure evaluation, it is assumed that 95% of the normal limit value of the FTE, defined in the operating procedures, is 0.5 NM for the Basic-RNP 1 navigation specification.

b) The default value of the alerting functionality of a TSO-C129a sensor (stand-alone or integrated) switches between terminal alerting (± 1 NM) and en-route alerting (± 2 NM) at 30 miles from the airport reference point (ARP).

7. AIRWORTHINESS AND OPERATIONAL APPROVAL

7.1 For a commercial air transport operator to be granted a Basic-RNP 1 approval, it must comply with two types of approvals:

a) the airworthiness approval, issued by the State of registry (see Article 31 of the Chicago Convention, and Paragraphs 5.2.3 and 8.1.1 of Annex 6 Part I); and

b) the operational approval, issued by the State of the operator (see paragraph 4.2.1 and Attachment F to Annex 6 Part I).

7.2 For general aviation operators, the State of registry will determine whether or not the aircraft meets the applicable basic RNP 1 requirements and will issue the operational approval (*e.g*., letter of authorisation – LOA) (see Paragraph 2.5.2.2 of Annex 6 Part II).

7.3 Before filing the application, operators shall review all aircraft qualification requirements. Compliance with airworthiness requirements or equipment installation alone does not constitute operational approval.

8. AIRWORTHINESS APPROVAL

8.1 System and aircraft requirements

8.1.1 Description of the RNP navigation system

a) **Lateral navigation (LNAV)**

1) In LNAV, the RNP equipment allows the aircraft to fly in accordance with the appropriate route instructions along a path defined by waypoints (WPTs) contained in an on-board navigation database.

__Note.-__ LNAV is normally a mode of flight guidance systems, in which the RNP equipment provides path steering commands to the flight guidance system, which controls the FTE through the manual pilot control on a path deviation display or through the coupling of the flight director (FD) or automatic pilot (AP).

2) For purposes of this AC, Basic-RNP 1 operations are based on the use of RNP equipment that automatically determines the position of the aircraft on the horizontal plane, using data input from the GNSS.

8.1.2 System performance, control, and alerting

a) **Accuracy.-** For operations in Basic-RNP 1 designated airspace or routes, total lateral system error must not exceed ± 1 NM during at least 95% of total flight time. Likewise, along-track error must not exceed ± 1 NM during at least 95% of total flight time. In order to meet the accuracy requirement, 95% of the flight technical error (FTE) must not exceed 0.5 NM.

__Note.-__ The use of a deviation indicator with a full-scale deflection of 1 NM constitutes an acceptable means of compliance. The use of a flight director (FD) or an automatic pilot (AP) also represents an acceptable means of compliance (roll stabilization systems do not meet the requirements).

b) **Integrity.-** Malfunctioning of the aircraft navigation equipment is classified as a major failure according to airworthiness regulations (*e.g*., 10^{-5} per hour).

c) **Continuity.-** Loss of function is classified as a minor failure if the operator can revert to a different navigation system and proceed to an appropriate aerodrome.

d) **Performance monitoring and alerting.-** The RNP system or the RNP system in combination with the pilot will provide an alert if the accuracy requirement is not met, or if the probability that the lateral total system error (TSE) exceeds 2 NM is greater than 10^{-5} per hour.

e) **Signal-in-space.-** If GNSS is used, the aircraft navigation equipment will provide an alert if the probability of signal-in-space errors causing a lateral position error greater than 2 NM exceeds 10^{-7} per hour (Annex 10, Volume I, Table 3.7.2.4.1).

8.1.3 **Aircraft eligibility requirements for Basic-RNP 1 operations in terminal area**

The following systems installed in the aircraft meet the requirements defined in this AC. This equipment requires evaluation by the manufacturer and operator against all the functional and performance requirement established in this AC.

a) Aircraft with E/TSO-C129a Class A1 system or E/TSO-C146 () system installed for IFR use in accordance with FAA AC 20-138 or AC 20-138A;

b) Aircraft with E/TSO-C129/C129a sensor (Class B or C) installed in a flight management system (FMS) that meets the criteria of TSO-C115b and installed for IFR use in accordance with AC 20-130A;

c) Aircraft with E/TSO-C145 () sensor installed in an FMS that meets TSO-C115b requirements and installed for IFR use in accordance with FAA AC 20-130A or AC 20-138A; and

d) Aircraft with certified RNP capability, or approved based on equivalent standards.

8.1.4 **System eligibility requirements for Basic-RNP 1 operations**

a) **Stand-alone systems.-** Stand-alone E/TSO-C129 Class A1 or A2 systems (without deviation from AC 91-008 functional requirements) or E/TSO-C146 Class 1, 2 or 3 systems (without deviation of functional requirements establish in this AC) meet aircraft qualification requirements for Basic-RNP 1 operations. GNSS systems must be approved in accordance with AC 20-138A.

b) **Multi-sensor systems.-** Multi-sensor systems using E/TSO-C129 Clase B o C sensors or E/TSO-C145 Class 1, 2 and 3 sensors, meet aircraft qualification requirements for Basic-RNP 1 operations, provided that the instalations comply with the criteria of this AC. RNP systems must be installed in accordance with AC 20-138A and the associated FMS must comply with E/TSO-C115b and AC 20-130A.

8.2 **Qualification documentation**

a) **Aircraft qualification documentation**

1) Aircraft or avionics manufacturers must produce aircraft qualification documentation showing compliance with the applicable criteria, as appropriate. For aircraft not approved for flying Basic-RNP 1 procedures, aircraft and avionics manufacturers must develop aircraft qualification documentation showing compliance with this AC, provided the equipment is properly installed and operated. The necessary documentation shall also define the appropriate maintenance procedures. This documentation is not required for aircraft that have an AFM or AFM supplement that explicitly states that the RNP system is approved for operations with values of RNP 1 or lower, and that the equipment meets the reliability and performance requirements of the following documents: AC 20-138A, AC 20-130A, E/TSO-C115b and AC 20-129, as applicable.

2) Operators will submit this documentation, together with the formal application, in Phase 2 of the approval process.

b) **Acceptance of documentation by the CAA**

1) *For new aircraft/equipment (capability shown in production)*.- The new aircraft/equipment qualification documentation may be approved as part of an aircraft certification project, and will be reflected in the AFM and related documents.

2) *For aircraft/equipment in use*.- Previous approvals to conduct RNAV 1 procedures using the GNSS (GPS), according to AC 91-003 or AC 90-100/AC 90-100A, do not require an additional assessment, provided it is shown that the RNAV equipment meets the on-board performance monitoring and alerting requirements. For installations/equipment that are not eligible for conducting Basic-RNP 1 procedures, the operator shall send the Basic-RNP 1 and aircraft qualification documentation to the corresponding bodies of the CAA (*e.g.*,

Aircraft certification division or Airworthiness inspection division, or equivalents).

3) The corresponding bodies of the CAA, as appropriate, will accept the data package for Basic-RNP 1 operations. This acceptance will be documented in a letter to the operator.

8.3 **Aircraft and systems eligibility for Basic-RNP 1 operations in terminal area**

8.3.1 **Aircraft that have a statement of compliance with respect to the criteria of this AC.-** Aircraft that have a statement of compliance with respect to the criteria set forth in this AC or equivalent document (*e.g.*, FAA AC 90-105 Appendix 2) in the AFM, AFM supplement, pilot operating handbook (POH) or avionics operating manual, meet the performance and functional requirements of this CA.

8.3.2 **Aircraft with a statement by the manufacturer**.- Aircraft that have a statement by the manufacturer documenting compliance with the criteria set forth in this AC or equivalent meet the performance and functional requirements of this document. This statement must include the airworthiness basis for compliance. The aircraft or equipment manufacturer will determine compliance with sensor requirements, while the operator will determine, through inspection, compliance with the functional requirements of this document.

8.3.3 For modified aircraft, the original equipment manufacturer (OEM) or the holder of the aircraft installation approval, *e.g.,* the holder of a supplemental type certificate (STC), will demonstrate compliance to the CAA, and the approval can be submitted in the documentation of the manufacturer (*e.g.*, service letters).

8.3.4 Stand-alone GNSS systems must be approved according to E/TSO-C129a Class A1 or E/TSO-C146 and operational Class 1, 2 or 3 (with no deviation from the functional requirements described in this AC), and installed for IFR use in accordance with AC 20-138A.

8.3.5 Aircraft with E/TSO-C129a sensor(s) Class B or C or E/TSO-C145 sensor(s) and FMS that meet E/TSO-C115b requirements and are installed for IFR use according to FAA AC 20-130A.

8.3.6 Aircraft/equipment approved under SRVSOP AC 91-003 or equivalent (*e.g.,* FAA AC 90-100A) for the use of GNSS, are approved under this AC for Basic-RNP 1 operations.

8.3.7 RNP aircraft with P-RNAV approval based on GNSS capability meet the functional requirements of this AC for Basic-RNP 1 operations, such as SIDs y STARs. The GNSS system approved according to E/TSO-C129 and satisfying the step-detection and health word checking contained in E/TSO-C129A, meets P-RNAV performance requirements.

Note.- *Basic-RNP 1 operations are based on GNSS positioning*. *Positioning data from other navigation sensors can be integrated into GNSS data provided they do not cause position errors that exceed the total system error (TSE) budget. Otherwise, means to deselect or cancel the other types of navigation sensors must be provided.*

8.4 **Functional requirements**

Appendix 1 contains the functional requirements that meet the criteria of this document.

8.5 **Continued airworthiness**

a) The operators of aircraft approved to perform Basic-RNP 1 operations, must ensure the continuity of the technical capacity of them, in order to meet technical requirements established in this AC.

b) Each operator who applies for Basic-RNP 1 operational approval shall submit to the CAA of State of registry, a maintenance and inspection program that includes all those requirements of maintenance necessary to ensure that navigation systems continue fulfilling the Basic-RNP 1 approval criteria.

c) The following maintenance documents must be revised, as appropriate, to incorporate Basic-RNP 1 aspects:

1) Maintenance control manual (MCM);

2) Illustrated parts catalogs (IPC); and

3) Maintenance program.

d) The approved maintenance program for the affected aircrafts should include maintenance practices listed in maintenance manuals of the aircraft manufacturer and its components, and must consider:

1) that equipment involved in the Basic-RNP 1 operation should be maintained according to directions given by manufacturer's components;

2) that any amendment or change of navigation system affecting in any way Basic-RNP 1 initial approval, must be forwarded and reviewed by the CAA for its acceptance or approval of such changes prior to its implementation; and

3) that any repair that is not included in the approved/accepted maintenance documentation, and that could affect the integrity of navigation performance, should be forwarded to the CAA for acceptance or approval thereof.

e) Within the Basic-RNP 1 maintenance documentation should be presented the training program of maintenance personnel, which inter alia, should include:

1) PBN concept;

2) Basic-RNP 1 application;

3) equipment involved in an Basic-RNP 1 operation; and

4) MEL use.

9. OPERATIONAL APPROVAL

Airworthiness approval alone does not authorise an applicant or operator to conduct basic RNP 1 operations. In addition to the airworthiness approval, the applicant or operator must obtain an operational approval to confirm the suitability of normal and contingency procedures in connection to the installation of a given piece of equipment.

Concerning commercial air transport, the assessment of an application for Basic-RNP 1 operational approval is done by the State of the operator, in accordance with standing operating rules (*e.g.*, LAR 121.995 (b) and LAR 135.565 (c) or equivalents) supported by the criteria described in this AC.

For general aviation, the assessment of an application for Basic-RNP 1 operational approval is carried out by the State of registry, in accordance with standing operating rules (*e.g.*, LAR 91.1015 and LAR 91.1640 or equivalents) supported by the criteria established in this AC.

9.1 Requirements to obtain operational approval

9.1.1 In order to obtain Basic-RNP 1 approval, the applicant or operator will take the following steps, taking into account the criteria established in this paragraph and in Paragraphs 10, 11, 12, and 13:

a) *Airworthiness approval*.- Aircraft shall have the corresponding airworthiness approvals, pursuant to Paragraph 8 of this CA.

b) *Application*.- The operator shall submit the following documentation to the CAA:

1) *Basic-RNP 1 operational approval application;*

2) *Description of aircraft equipment*.- The operator shall provide a configuration list with details of the relevant components and the equipment to be used for Basic-RNP 1 operations. The list shall include each manufacturer, model, and equipment version of GNSS equipment and software of the installed FMS.

3) *Airworthiness documents related to aircraft eligibility*.- The operator shall submit relevant documentation, acceptable to the CAA, showing that the aircraft is equipped with RNP systems that meet the Basic-RNP 1 requirements, as described in Paragraph 8 of this AC.

For example, the operator will submit the parts of the AFM or AFM supplement that contain the airworthiness statement.

4) *Training programme for flight crews and flight dispatchers (DV)*

(a) Commercial operators (*e.g.*, LAR 121 and LAR 135 operators) will present to the CAA the Basic-RNP 1 training curriculums to show that the operational procedures and practices and the training aspects described in Paragraph 11 have been included in the initial, upgrade or recurrent training curriculums for flight crews and DV.

Note.- *It is not necessary to establish a separate training programme if the Basic-RNP 1 training identified in Paragraph 11 has already been included in the training programme of the operator. However, it must be possible to identify what aspects of Basic-RNP 1 are covered in the training programme.*

(b) Private operators (*e.g*., LAR 91 operators) shall be familiar with and demonstrate that they will perform their operations based on the practices and procedures described in Paragraph 11.

5) *Operations manual and checklists*

(a) Commercial operators (*e.g.*, LAR 121 and 135 operators) must review the operations manual (OM) and the checklists in order to include information and guidance on the operating procedures detailed in Paragraph 10 of this AC. The appropriate manuals must contain the operating instructions for navigation equipment and contingency procedures. The manuals and checklists must be submitted for review along with the formal application in Phase 2 of the approval process.

(b) Private operators (*e.g.*, LAR 91 operators) must operate their aircraft based on the practices and procedures identified in Paragraph 10 of this CA.

6) *Minimum Equipment List (MEL)*.- The operator will send to the CAA for approval any revision to the MEL that is necessary to conduc Basic-RNP 1 operations. If a Basic-RNP 1 operational approval is granted based on a specific operational procedure, operators must modify the MEL and specify the required dispatch conditions.

7) *Maintenance*.- The operator will submit for approval a maintenance programme to conduct Basic-RNP 1 operations.

8) *Training programme for maintenance personnel*.- Operators will submit the training curriculums that correspond to maintenance personnel in accordance with Paragaraph 8.5 e).

9) *Navigation data validation programme*.- The operator will present the details about the navigation data validation programme as described in Appendix 2 to this AC.

c) *Training*.- Once the amendments to manuals, programmes, and documents submitted have been accepted or approved, the operator will provide the required training to its personnel.

d) *Validation flight*.- The CAA may deem it advisable to perform a validation flight before granting the operational approval. Such validation can be performed on commercial flights. The validation flight will be carried out according to the provisions of Chapter 13, Volume II, Part II of the SRVSOP Operations Inspector Manual (MIO) of the Regional Safety Oversight Cooperation System (SRVSOP).

e) *Issuance of the approval to conduct Basic-RNP 1 operations*.- Once the operator has successfully completed the operational approval process, the CAA will grant the operator the authorization to conduct Basic-RNP 1 operations.

1) LAR 121 and/or 135 operators.- For LAR 121 and/or LAR 135 operators, the CAA will issue the corresponding operations specifications (OpSpecs) that will reflect the basic RNP 1 approval.

2) *LAR 91 operators*.- For LAR 91 operators, the CAA will issue a letter of authorization

(LOA).

10. OPERATING PROCEDURES

10.1 The operator and the flight crews will become familiar with the following operating and contingency procedures associated with Basic-RNP 1 operations.

a) **Pre-flight planning**

1) Operators and pilots intending to conduct Basic-RNP 1 SIDs and STARs must fill out the appropriate boxes in the ICAO flight plan.

2) On-board navigation data must be current and include appropriate procedures.

Note.- *It is expected that the navigation database will be up to date during the operation. If the AIRAC cycle expires during the flight, operators and pilots shall establish procedures to ensure the precision of navigation data, including the suitability of navigation facilities used to determine the routes and procedures for the flight. Normally, this is done comparing electronic data with written documents. An acceptable means of compliance is to compare aeronautical charts (new and old) to check navigation reference points before dispatch. If an amended chart is published for the procedure, the database must not be used to conduct the operation.*

3) The availability of the NAVAID infrastructure required for the intended routes, including any non-RNP contingency, must be confirmed for the period of intended operations, using all available information. Since Annex 10 Volume I requires GNSS integrity (RAIM or SBAS), it is also necessary to confirm apropiate availability of these devices. For aircraft that navigate with SBAS receivers [all TSO-C145 () / C146 () receivers], operators shall confirm appropriate availability of the GNSS RAIM in areas where the SBAS signal is not available.

4) RAIM (ABAS) availability

(a) RAIM levels required for Basic-RNP 1 can be verified either through NOTAMs (where available) or through prediction services. Operators must be familiar with the prediction information available for the intended route.

(b) For systems whose integrity is based on RAIM, RAIM prediction must be done before departure. This capability can be provided by a ground service or through the RAIM prediction capability of the aircraft on-board receiver.

(c) The prediction of RAIM availability must take into account the last NOTAMs of the GPS constellation and the avionics model (if available). The RAIM prediction service can be provided through the ANSPs, the avionics manufacturers, other entities, or through the RAIM prediction capability of the aircraft on-board receiver. RAIM availability can be confirmed using a model-specific RAIM prediction software.

(d) The predictive capability must account for known and predicted outages of GPS satellites or other effects on the navigation system sensors. The prediction programme should not use a mask angle below 5 degrees, since operational experience inicates that satellite signals on low elevations are not reliable. RAIM availability prediction should take into account the latest GPS constellation notices to airmen (NOTAMs) issued by the CAA or by the ANSPs, and use an identical algorithm to that used in the airborne equipment or an algorithm based on assumptions for RAIM prediction that provides a more conservative result.

(e) In the event that a continuous loss of the appropriate failure detection level is forecast for more than five (5) minutes for any portion of the Basic-RNP 1 operation, the flight plan shall be revised (*e.g.*, delaying the departure or planning a different departure procedure).

(f) The RAIM availability prediction software does not guarantee the service. This software is rather a tool for assessing the expected capacity to meet the required navigation performance. Due to unplanned failures of some GNSS elements, pilots and ANSPs must understand that both RAIM and GNSS navigation can be lost while the aircraft is on flight, which may require reversal to an alternate means of navigation. Therefore, pilots must assess their navigation capabilities (potentially to an alternate aerodrome) in case of failure of GNSS navigation. If system integrity needs to be verified, the RAIM prediction programme shall meet the criteria of FAA AC 20-138, Paragraph 12.

(g) For aircraft navigating with SBAS receivers (all E/TSO-C145/C146), operators must take into account the latest GPS constellation and SBAS NOTAMs. Operators must also check appropriate GPS RAIM availability in areas where SBAS signal is unavailable.

b) **General operating procedures**

1) The pilot shall comply with any instruction or procedure identified by the manufacturer, as necessary, to meet the performance requirements of this section.

Note.- *Pilots must adhere to any AFM limitation or operating procedure required to maintain Basic-RNP 1 performance.*

2) Operators and pilots shall not request or file Basic-RNP 1 routes, SIDs or STARs, unless they meet all the criteria set forth in this AC. If an aircraft that does not meet these criteria and is cleared by the ATC to conduct a Basic-RNP 1 procedure, the pilot will notify the ATC that it cannot accept such clearance and will request alternate instructions;

3) At system initialization, pilots must:

(a) confirm that the navigation database is current;

(b) verify that the aircraft position has been entered correctly;

(c) verify the appropriate entry of the assigned ATC route once they receive the initial clearance, and of any subsequent change in route; and

(d) ensure that the sequence of WPTs as depicted in their navigation system matches the route drawn in the appropriate charts and the assigned route.

4) Pilots shall not fly a Basic-RNP 1 procedure, unless it can be retrievable from the on-board navigation database by its name, and conforms with the procedure in the chart. However, the procedure can be modified afterwards by inserting or deleting specific WPTs in response to ATC clearance. Manual entry or the creation of new WPTs through manual insertion of latitude and longitude or rho/theta values is not permitted. Likewise, pilots must not change any type of WPT from a fly-by WPT to a flyover WPT or *vice versa*.

5) Flight crews shall cross-check the cleared flight plan by comparing charts or other applicable resources to the navigation system text displays and aircraft map displays, as applicable. If required, the exclusion of specific NAVAIDs must be confirmed. A procedure shall not be used if there are any doubts about the validity of the procedure in the navigation database.

Note.- *Pilots may note a small difference between the navigation information described in the chart and the primary navigation display. Differences of 3° or less may result from applying the magnetic variation to the equipment of the manufacturer, and these are operationally acceptable.*

6) A cross-check is not required for conventional NAVAIDs, since the absence of integrity alert is considered sufficient to meet integrity requirements. However, it is suggested that the navigation reasonableness be checked, and any loss of RNP capability must be reported to the ATC.

7) For Basic-RNP 1 procedures, pilots must use a lateral deviation indicator, an FD or an AP in lateral navigation mode (LNAV). Pilots of aircraft with a lateral deviation display must make sure that the lateral deviation scale is appropriate for the navigation precision

associated to the route/procedure (*e.g.,* full-scale deflection: ± 1 NM for Basic-RNP 1).

8) All pilots are expected to follow the route centreline, as represented on the on-board lateral deviation indicators and/or flight guidance, during all Basic-RNP 1 operations, unless cleared by the ATC to deviate or due to an emergency. For normal operations, the cross-track error/deviation (the difference between the path estimated by the RNP system and the position of the aircraft relative to the path, *e.g.* FTE) must be limited to ± ½ the navigation precision associated with the procedure (*e.g.*, 0.5 NM for basic RNP 1). Small lateral deviations from this requirement are allowed (*e.g.*, overshooting or undershooting the path) during or immediately after a turn, up to a maximum of 1 times the navigation precision (1xRNP) (*e.g.*, 1 NM for basic RNP 1).

Note.- *Some aircraft do not display or do not estimate a path during turns. Pilots of such aircraft may not be capable of meeting the ± ½ precision requirement during en-route turns; however, they are expected to meet interception requirements after the turn or in straight segments.*

9) If the ATC issues a course assignment that places the aircraft out of the route, the pilot shall not modify the flight plan in the RNP system until a new clearance is received allowing the aircraft to return to the route or until the controller confirms a new route clearance. When the aircraft is not on the published Basic-RNP 1 route, the specified precision requirements do not apply.

10) Manual selection of functions that limit the banking angle of the aircraft can reduce the ability of the aircraft to maintain its desired track and is not recommended. Pilots should acknowledge that manual selection of functions that limit the banking angle of the aircraft could reduce their ability to meet ATC path expectations, especially when turns with large banking angles are performed. This cannot be construed as a requirement to deviate from AFM procedures. Pilots must be encouraged to select such functions only within accepted procedures.

11) Pilots operating aircraft that have a barometric vertical navigation system (baro-VNAV) can continue using said system while conducting Basic-RNP 1 SID and STAR procedures. Operators must ensure compliance with all altitude limitations, as published in the procedure, using the barometric altimeter as reference. Use of the barometric vertical navigation capability of the aircraft will be subject to the level of familiarisation and training of the flight crew, and on any other operational approval requirement.

12) Before starting a Basic-RNP 1 procedure, flight crews must:

(a) confirm that the correct procedure has been selected. This process includes verifying WPT sequence, the reasonableness of track angles, distances, and of any other parameter that can be modified by the pilot, such as altitude or speed constraints; and

(b) for multi-sensor systems, verify that the correct sensor is being used for position computation.

c) **Aircraft with RNP selection capability**

Pilots of aircraft with the capability of selecting RNP input must select RNP 1 or lower for Basic-RNP 1 SIDs, STARs or procedures.

d) **Basic-RNP 1 SID specific requirements**

1) Before beginning take-off, the pilot must verify that the airborne Basic-RNP 1 system is available and operating correctly, and that the appropriate aerodrome and runway data have been loaded. Before the flight, pilots must verify that the airborne navigation system is operating correctly and that the appropriate runway and departure procedure (including any applicable en-route transition) have been loaded and are properly displayed. Pilots assigned to a Basic-RNP 1 departure procedure and subsequently receive a change of runway, procedure or transition, must verify that the appropriate changes have been entered and are available for navigation before take-off. A final

check of proper runway entry and correct route depiction, shortly before take-off, is recommended.

2) *Altitude for engagement the RNAV equipment*.- The pilot must be capable of connecting the RNP equipment in order to follow the flight guidance in the RNP lateral navigation mode before reaching 153 m (500 ft) above the aerodrome elevation.

3) Pilots must use an authorised method (lateral deviation indicator/navigation map display/FD/AP) to achieve an appropriate level of performance for Basic-RNP 1.

4) *GNSS aircraft.-* When a GNSS is used, the signal must be obtained before starting the take-off roll. For aircraft using E/TSO-C129a equipment, the take-off aerodrome must be loaded into the flight plan in order to achieve the appropriate navigation system monitoring and sensitivity. For aircraft using E/TSO-C145 ()/C146 () equipment, if the departure starts at a runway waypoint (WPT), then the departure aerodrome does not need to be in the flight plan in order to obtain the appropriate monitoring and sensitivity mentioned above. If a Basic-RNP 1 SID extends beyond 30 NM from the aerodrome and a lateral deviation indicator is used, its full-scale sensitivity must be set to a value not greater than 1 NM between 30 NM from the aerodrome and the termination of the Basic-RNP 1 SID.

5) For aircraft using a lateral deviation display (*e.g.*, a navigation map display), the scale must be adjusted for the Basic-RNP 1 SID and FD or AP must be used.

e) **Basic-RNP 1 STAR specific requirements**

1) Before the arrival phase, the flight crew shall verify that the correct terminal route has been loaded. The active flight plan shall be checked, comparing the charts to the map display (if applicable) and the multi-function control display unit (MCDU). This includes confirmation of WPT sequence, the reasonableness of track angles and distances, any altitude or speed contraints, and, whenever possible, which are fly-by WPTs and which are flyover WPTs. If required by a route, a check will need to be made to confirm that updating will exclude a particular NAVAID. A route will not be used if there are doubts about its validity in the navigation database.

Note.- *As a minimum, verifications in the arrival phase could consist of a simple inspection of a suitable map display that will meet the objectives of this paragraph.*

2) The creation of new WPTs by the flight crew through manual entries into the Basic-RNP 1 system will invalidate any route, and is not permitted.

3) When contingency procedures require reverting to a conventional arrival route, the flight crew must make the necessary preparations before starting the Basic-RNP 1 procedure.

4) Modification made to a route in the terminal area may take the form of radar headings or “direct to” clearances. In this sense, the flight crew must be capable of reacting in time. This may include the insertion of tactical WPTs loaded from the database. The flight crew is not allowed to make manual entries or to modify a loaded route, using temporary WPT or fixes not provided in the database.

5) Pilots must verify that the aircraft navigation system is operating properly and that the correct arrival procedure and runway are properly entered and displayed.

6) Although a particular method is not mandated, any published altitude and speed constraints must be observed.

7) Aircraft with E/TSO-C129a GNSS RNP systems: If a Basic-RNP 1 STAR begins beyond 30 NM from the aerodrome and a lateral deviation indicator is used, its full-scale sensitivity must be set to a value not greater than 1 NM before commencing the STAR. For aircraft that use a lateral deviation display (*e.g.*, a navigation map display), the scale must be adjusted to the Basic-RNP 1 STAR and the FD or AP must be used.

f) **Contingency procedures**

1) The pilot must notify the ATC of any loss of RNP capability (integrity alerts or loss of navigation), together with the proposed course of action. If, for any reason, it is not possible to meet the requirements of a Basic-RNP 1 SID or STAR, pilots must notify the ATS as soon as possible. Loss of RNP capability includes any failure or event that causes the aircraft to be unable to meet the Basic-RNP 1 requirements of the route.

2) In case of a communication failure, the flight crew must continue with the established procedure for loss of communication.

11. TRAINING PROGRAMMES

11.1 The training programme for flight crews and flight dispatchers (DV) shall provide sufficient training (*e.g.*, using flight training devices, flight simulators and aircraft) on the RNP system to the extent necessary. The training programme will include the following topics:

a) information about this AC;

b) the meaning and proper use of aircraft equipment and navigation suffixes;

c) the procedures characteristics as determined from chart depiction andtextual description;

d) the depiction of WPTs types (fly-by and flyover) and ARINC 424 path terminators provided in Appendix 1 to this AC and any other types used by the operator, as well as those associated with the aircraft flight paths;

e) the navigation equipment required to conduct Basic-RNP 1 SIDs and STARs.

f) specific information on the RNP system:

   1) levels of automation, annunciation modes, changes, alerts, interactions, reversals, and degradation;

   2) integration of functions with other aircraft systems;

   3) the meaning and appropriateness of route discontinuities as well as related flight crew procedures;

   4) pilot procedures consistent with the operation;

   5) types of navigation sensors (*e.g.*, GNSS) used by the RNP system and associated system prioritization, weighting and logic;

   6) turns anticipation, taking into account the effects of speed and altitude;

   7) interpretation of electronic displays and symbols;

   8) understanding aircraft configuration and operational conditions required to support Basic RNP 1 operations; *e.g.*, appropriate selection of the lateral deviation indicator (CDI) scaling;

g) operating procedures for RNP equipment, as applicable, including how to perform the following:

   1) verify currency and integrity of aircraft navigation data;

   2) verify the successful completion of RNP system selft-tests;

   3) initialize RNP system position;

   4) retrieve and fly a Basic-RNP 1 SID or STAR with the appropriate transition;

   5) adhere to speed and altitude constraints associated with a Basic-RNP 1 SID or STAR;

   6) select the appropriate Basic-RNP 1 SID or STAR for the active runway and become familiar with the procedures to deal with a runway change;

   7) verify WPTs and flight plan programming;

8) fly direct to a WPT;

9) fly a course/track to a WPT;

10) intercept a course/track;

11) fly radar vectors and rejoining a Basic-RNP 1 route from a “heading” mode;

12) determine cross-track errors and deviations; specifically, the maximum allowable deviations to support Basic-RNP 1 must be understood and respected;

13) resolve route discontinuities (insert and delete/eliminate en-route discontinuities);

14) remove or reselect the navigation sensor inputs;

15) when required, confirm the exclusion of a specific NAVAID or a type of navigation aid;

16) change the arrival and alternate erodromes;

17) perform parallel offset if that capability is available. Pilots must know how to apply offsets, the functionality of the particular RNP system, and the need to advise the ATC if this functionality is not available; and

18) perform RNP holding pattern functions (*e.g.*, insert or delete a holding pattern).

h) levels of automation recommended by the operator for each flight phase and workload, including the methods to minimise cross-track error that will permit the aircraft to follow the route centreline;

i) radiotelephony phraseology used for RNP applications; and

j) RNP failure contingency procedures.

12. NAVIGATION DATABASE

a) The operator must obtain the navigation database from a supplier that complies with RTCA (Radio Technical Commission for Aeronautics) document DO 200A/EUROCAE ED 76 – Standards for aeronautical data processing. Navigation data must be compatible with the foreseen function of the equipment (see Annex 6 Part I paragraph 7.4.1). A letter of acceptance (LOA) issued by the appropriate regulatory authority to each participant in the data chain shows compliance with this requirement (*e.g*., FAA LOA issued in accordance with FAA AC 20-153 or EASA LOA issued in accordance with EASA IR 21 Subpart G).

b) The operator must advise the navigation data supplier of discrepancies that invalidate a SID or STAR, and prohibit their use through a notice to flight crews.

c) Operators should consider the need to check the navigation database periodically in order to maintain the requirements of the existing quality system or safety management system.

Note.- *In order to minimise the path definition error (PDE), the database shall comply with DO 200A or there must be an equivalent operational means available to ensure database integrity for the Basic-RNP 1 SIDs or STARs.*

13. OVERSIGHT, INVESTIGATION OF NAVIGATION ERRORS, AND WITHDRAWAL OF BASIC-RNP 1 APPROVAL

a) The operator will establish a procedure to receive, analyse, and follow up on navigation error reports in order to determine appropriate corrective action.

b) Information indicating a potential for repetitive errors may require the modification of the training programme of the operator.

c) Information attributing multiple errors to a pilot in particular may call for additional training or a license revision for that pilot.

d) Repetitive navigation errors attributed to the equipment or a specific part of the navigation equipment or to operating procedures can be the cause of cancellation of an operational approval (withdrawal of Basic-RNP 1 OpSpecs authorisation or withdrawal of the LOA in the case of private operators).

APPENDIX 1

FUNCTIONAL REQUIREMENTS

Paragraph	Functional requirements	Explanation
a)	Navigation data, including the to/from indication and a failure indicator, must be displayed on a lateral deviation display [*e.g.,* a course deviation indicator (CDI), an enhanced horizontal situation indicator (E)HIS) and/or a navigation map display]. These lateral deviation displays will be used as primary flight instruments for the navigation of the aircraft, for manoeuvre anticipation, and for indication of failure/status/integrity. They must meet the following requirements:	1) Non-numeric lateral deviation display (e.g. CDI, (E)HSI)), with a to/from indication and a failure annunciation, for use as primary flight instruments for navigation of the aircraft, for manoeuvre anticipation, and for failure/status/integrity indication, with the following five attributes: (a) The displays must be visible to the pilot and located in the primary field of view (±15 degrees from the pilot's normal line of sight) when looking forward along the flight path. (b) The lateral deviation display scaling should agree with any alerting and annunciation limits, if implemented. (c) The lateral deviation display must also have a full-scale deflection suitable for the current phase of flight and must be based on the required total system accuracy. (d) The display scaling may be set automatically by default logic or set to a value obtained from a navigation database. The full-scale deflection value must be known or must be available for display to the pilot commensurate with en-route, terminal, or approach values. (e) The lateral deviation display must be automatically slaved to the RNP computed path. The course selector of the deviation display should be automatically slewed to the RNP computed path. ***Note.-*** *The normal functions of the autonomous GNSS meet this requirement.* 2) As an alternate means, a navigation map display should give equivalent functionality to a lateral deviation display as described in Paragraph a) 1) from (a) to (e), with appropriate map scales which may be set manually by the pilot. ***Note.-*** *A number of modern aircraft eligible for this specification use a map display as an acceptable means to meet the prescribed requirements.*

Paragraph	Functional requirements	Explanation
b)	The following functions of the basic RNP 1 system are required as a minimum:	1) The capability to continuously display to the pilot flying (PF), on the primary flight navigation instruments (primary navigation displays), the RNP calculated desired path and the position of the aircraft relative to that path. For operations where the minimum flight crew consists of two pilots, the means for the pilot not flying (PNF) the aircraft or monitoring pilot (MP) to verify the desired path and the aircraft position relative to that path must also be provided; 2) A navigation database containing current navigation data officially issued for civil aviation, which can be updated in accordance with the aeronautical information regulation and control (AIRAC) cycle and from which ATS routes can be retrieved and loaded into the RNP system. The resolution of the stored data must be sufficient to achieve an insignificant path definition error (PDE). The database must be protected against any modification of the stored data by the flight crew; 3) The means to display to the flight crew the period of validity of the navigation database; 4) The means to retrieve and display the data stored in the navigation database relating to individual waypoints and NAVAIDs, to enable the flight crew to verify the route to be flown; and 5) The capability to load on the Basic-RNP 1 system, from the navigation database, the complete RNP segment of the SIDs or STARs to be flown. ***Note.-*** *Due to the variability of RNP systems, this document defines the RNP segment from the first occurrence of a named WPT, track or course up to the last occurrence of a named WPT, track or course. Legs or segments prior to the first named WPT or after the last named WPT must not be loaded from the navigation database. Heading legs prior to the first named WPT or after the last named WPT do not have to be loaded from the navigation database. The complete SID will be considered in the Basic-RNP 1 procedure.*
c)	The means to display the following items, either on the primary field of view of the pilots, or on a readily accessible display page [*e.g.*, on a multi-function control display unit	1) The active navigation sensor type; 2) The identification of the active (to) waypoint; 3) The ground speed or time to the active (to) waypoint; and

Paragraph	Functional requirements	Explanation
	(MCDU)]:	4) The distance and bearing to the active (to) waypoint.
d)	The capability of execute a "direct to" function.	
e)	The capability for automatic leg sequencing with the display of sequencing to the flight crew.	
f)	The capability to execute Basic-RNP 1 terminal procedures extracted from the on-board database, including the capability to execute flyover and fly-by turns.	
g)	The aircraft must have the capability to automatically execute leg transitions and maintain tracks consistent with the following ARINC 424 path terminators or their equivalent: ➢ Initial fix (IF); ➢ Course to a fix (CF); ➢ Direct to a fix (DF); and ➢ Track to a fix (TF).	***Note 1.-*** *Path terminators are defined in the ARINC 424 specification, and their application is described in more detail in RTCA documents DO-236B and DO-201A and in EUROCAE ED-75B and ED-77* ***Note 2.****- Numeric values for courses and tracks must be automatically loaded from the RNP system database.*
h)	The aircraft must have the capability to automatically execute leg transitions consistent with the following ARINC 424 path terminators: heading to an altitude (VA), heading to a manual termination (VM) and heading to an intercept (VI), or must be able to be manually flown on a heading to intercept a course or to fly direct to another fix after reaching an altitude of a specific procedure.	
i)	The aircraft must have the capability to automatically execute leg transitions consistent with the following ARINC 424 path terminators: course to an altitude (CA) and course from a fix to a manual termination (FM), or the RNP	

Paragraph	Functional requirements	Explanation
	system must permit the pilot to readily designate a waypoint and select a desired course to or from a designated waypoint.	
j)	The capability to load an Basic-RNP 1 procedure from the database into the RNP system by its name.	
k)	The capability to display an indication of the Basic-RNP 1 system failure in the pilot´s primary field of view.	
l)	Database integrity	The navigation database suppliers must comply with RTCA DO-200/EUROCAE document ED 76 - Standards for processing aeronautical data. A Letter of acceptance (LOA) issued by the appropriate regulatory authority to each of the participants in the data chain demonstrates compliance with this requirement. Discrepancies that invalidate a route must be reported to database suppliers and the affected routes must be prohibited through a notice from the operator to its flight crews. Aircraft operators must consider the need to conduct periodic checks of the navigation databases in order to meet existing safety system requirements.

APPENDIX 2

NAVIGATION DATA VALIDATION PROGRAMME

1. INTRODUCTION

The information stored in the navigation database defines the lateral and longitudinal guidance of the aircraft for Basic-RNP 1 operations. Navigation database updates are carried out every 28 days. The navigation data used in each update are critical to the integrity of every basic RNP 1 procedure, SID and STAR. This appendix provides guidance on operator procedures to validate the navigation data associated with the Basic-RNP 1 operations.

2. DATA PROCESSING

a) The operator will identify in its procedures the person responsible for the navigation data updating process.

b) The operator must document a process for accepting, verifying, and loading navigation data into the aircraft.

c) The operator must place its documented data process under configuration control.

3. INITIAL DATA VALIDATION

3.1 The operator must validate every Basic-RNP 1 procedure, SID and STAR before flying under instrument meteorological conditions (IMC) to ensure compatibility with the aircraft and to ensure that the resulting paths are consistent with the published procedures, SIDs and STARs. As a minimum, the operator must:

a) compare the navigation data of Basic-RNP 1 procedures, SIDs, and STARs to be loaded into the FMS with valid charts and maps containing the published procedures, SIDs, and STARs.

b) validate the navigation data loaded for Basic-RNP 1 procedures, SIDs, and STARs, either on the flight simulator or on the aircraft, under visual meteorological conditions (VMC). Basic-RNP 1 procedures, SIDs, and STARs outlined on a map display must be compared to the published procedures, SIDs, and STARs. Complete Basic-RNP 1 procedures, SIDs, and STARs must be flown in order to ensure that the paths can be used, that they have no apparent lateral or longitudinal discrepancies, and that they are consistent with the published routes, SIDs, and STARs.

c) Once the Basic-RNP 1 procedures, SIDs, and STARs are validated, a copy of the validated navigation data shall be kept and maintained in order to compare them with subsequent data updates.

4. DATA UPDATING

Upon receiving a navigation data update and before using such data on the aircraft, the operator must compare the update with the validated procedures, SIDs or STARs. This comparison must identify and resolve any discrepancy in the navigation data. If there are significant changes (any change affecting the path or the performance of the procedures, SIDs and STARs) in any part of the procedure, SID, and STAR, and if those changes are verified through the initial data, the operator must validate the amended route in accordance with the initial validation data.

5. NAVEGATION DATA SUPPLIERS

Navigation data suppliers must have a letter of acceptance (LOA) in order to process these data (*e.g.*, FAA AC 20-153 or the document on the conditions for the issuance of letters of acceptance to navigation data suppliers by the European Aviation Safety Agency – EASA (EASA IR

21 Subpart G) or equivalent documents). A LOA recognises the data supplier as one whose data quality, integrity and quality management practices are consistent with the criteria of DO-200A/ED-76. The database supplier of an operator must have a Type 2 LOA and its respective suppliers must have a Type 1 or 2 LOA. The CAA may accept a LOA issued to navigation data suppliers or issue its own LOA.

6. AIRCRAFT MODIFICATIONS (DATABASE UPDATE)

If an aircraft system necessary for Basic-RNP 1 operations is modified (*e.g.*, change of software), the operator is responsible for validating the Basic-RNP 1 procedures, SIDs, and STARs with the navigation database and the modified system. This can be done without any direct assessment if the manufacturer confirms that the modification has no effect on the navigation database or on path calculation. If there is no such confirmation by the manufacturer, the operator must perform an initial validation of the navigation data with the modified system.

APPENDIX 3

BASIC-RNP 1 APPROVAL PROCESS

a) The Basic-RNP 1 approval process consists of two types of approvals, airworthiness and operational. Although the two have different requirements, they must be considered in one single process.

b) This process is an orderly method used by the CAA to make sure that the applicants meet the established requirements.

c) The approval process is made up by the following phases:

1)	Phase one:	Pre-application
2)	Phase two:	Formal application
3)	Phase three:	Documentation evaluation
4)	Phase four:	Inspection and demonstration
5)	Phase five:	Approval

d) In *Phase one - Pre-application*, the CAA calls the applicant or operator to a pre-application meeting. At this meeting, the CAA informs the applicant or operator of all the operational and airworthiness requirements that it must meet during the approval process, including the following:

1) the contents of the formal application;
2) the review and evaluation of the application by the CAA;
3) the limitations (if any) applicable to the approval; and
4) conditions under which the Basic-RNP 1 approval could be cancelled.

e) In *Phase two – Formal Application*, the applicant or operator submits the formal application along with all the relevant documentation, as established in Paragraph 9.1.1 b) of this AC.

f) In Phase three – *Documentation evaluation*, the CAA evaluates all the documentation and the navigation system to determine their eligibility and the approval method to be followed in connection with the aircraft. As a result of this analysis and evaluation, the CAA may accept or reject the formal application along with the documentation.

g) In *Phase four – Inspection and demonstration*, the operator will provide training to its personnel and will carry out the validation flight, if required.

h) In *Phase five* - Approval, the CAA issues the Basic-RNP 1 approval once the operator has met the airworthiness and operational requirements. For LAR 121 and 135 operators, the CAA will issue the OpSpecs, and for LAR 91 operators, a LOA.

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APPENDIX D-2

BASIC-RNP 1 JOB AID

REQUEST TO CONDUCT BASIC-RNP 1 OPERATIONS

BASIC-RNP 1 JOB AID

REQUEST TO CONDUCT BASIC-RNP 1 OPERATIONS

1. Introduction

This Job Aid was developed by the Latin American Regional Safety Oversight Cooperation System (SRVSOP) to provide States, operators, and inspectors with guidance on the process to be followed by an operator in order to obtain a Basic-RNP1 authorization.

2. Purpose of the Job Aid

2.1 To give operators and inspectors information on the main reference documents of Basic-RNP 1.
2.2 To provide tables showing the contents of the application, the associated reference paragraphs, the place in the application of the operator where Basic-RNP 1 elements are mentioned and columns for inspector comments and follow-up on the status of various elements of Basic-RNP 1.

3. Actions Recommended for the Inspector and Operator

Some recommendations for use of the Job Aid follow:

3.1 At the pre-application meeting with the operator, the inspector reviews the "basic events of the Basic-RNP 1 approval process "described in Part 1 of this Job Aid, in order to provide an overview of the approval process events.
3.2 The inspector reviews this Job Aid with the operator in order to establish the form and content of the Basic-RNP 1 approval application.
3.3 The operator uses this Job Aid as a guide to collect the documents/annexes of the Basic-RNP 1 application.
3.4 The operator inserts in the Job Aid references showing in what part of its documents are the Basic-RNP 1 programme elements located.
3.5 The operator submits the Job Aid and the application to the inspector (documents/annexes).
3.6 The inspector indicates in the Job Aid whether an item is in compliance or needs corrective action.
3.7 The inspector informs the operator as soon as possible when a corrective action by the operator is required.
3.8 The operator provides the inspector with the revised material when so requested.
3.9 The CAA provides the operator with the operational specifications (OpSpecs) or a letter of authorisation (LOA), as applicable, when the tasks and documents have been completed.

4. Structure of the Job Aid

Parts	Topics	Page
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5. Main sources of documents, information, and contacts

To access the Basic RNP 1 Job Aid, enter to the Web page of the ICAO/SAM Regional Office (www.lima.icao.int) under the SRVSOP link.

6. Main reference documents

Reference Document	Title
Annex 6	Operation of aircraft
ICAO Doc 9613	Performance based navigation (PBN) manual
FAA AC 90-105 Appendix 2	Qualification criteria for RNP 1 (terminal) operations
AMC 20-5	Acceptable means of compliance for airworthiness approval and operational criteria for the use of the NAVSTAR Global positioning system (GPS)
AC 20-130A	Airworthiness approval of navigation or flight management systems integrating multiple navigation sensors
AC 20-138A	Airworthiness approval of Global navigation satellite system (GNSS) equipment
TSO-C115b	Airborne area navigation equipment using multi-sensor inputs
TSO-C129a	Airborne supplemental navigation equipment using the global positioning system (GPS)
TSO-C145a	Airborne navigation sensors using the global positioning system (GPS) augmented by the wide area augmentation system (WAAS)
TSO-C146a	Stand-Alone airborne navigation equipment using the global positioning system (GPS) augmented by the wide area augmentation system (WAAS)

PART 1: GENERAL INFORMATION

Basic events in the Basic-RNP 1 approval process

	Action by the operator	Action by the CAA
1	Establishes the need to obtain Basic-RNP 1 authorization.	
2	Reviews the AFM, AFM supplement or Type Certificate Data Sheet (TCDS), or other appropriate documents (*e.g.,* service bulletins (SB), service letters (SL), etc.) to determine the eligibility of the aircraft for Basic-RNP 1 operations. The operator contacts the aircraft or avionics manufacturer, if necessary, to confirm Basic-RNP 1 or higher eligibility of the aircraft.	
3	Contacts the CAA to schedule a pre-application meeting to discuss the operational approval requirements.	
4		During the pre-application meeting, establishes: • the form and contents of the application; • the documents that support Basic-RNP 1 approval • the date in which the application will be submitted for evaluation • if necessary, conducts a validation flight observed by the CAA.
5	Submits the application at least 60 days before start-up of Basic-RNP 1 operations.	
6		Reviews the request of the operator.
7	Once the amendments to manuals, programmes, and documents have been approved, provides training to flight crews, flight dispatchers, and maintenance personnel, and conducts a validation flight, if required by the CAA.	Only if required, participates in the validation flight.
8		Once the operational and airworthiness requirements have been met, issues the operational approval in the form of OpSpecs for LAR 121 or 135 or equivalent operators, or an LOA for LAR 91 or equivalent operators, as appropriate.

Notes related to the approval process

1. **Responsible authority**

   a. **Commercial air transport (LAR 121 and/or 135 regulations or equivalent).-** The **State of Registry** determines that the aircraft meets the airworthiness requirements. The **State of the Operator** issues the Basic-RNP 1 approval (*e.g.,* OpSpecs).

   b. **General Aviation (LAR 91 regulations or equivalent).-** The **State of Registry** determines that the aircraft meets the airworthiness requirements and issues the operational approval (*e.g.,* an LOA).

2. The CAA does not need to issue an LOA or equivalent document for each individual area of operation in the case of LAR 91 operators.

3. LAR 121 and/or 135 operators with Basic-RNP 1 approval must list this approval in the OpSpecs.

4. Related sections of the Latin American Aeronautical Regulations (LAR) or equivalent regulations

   a. LAR 91 Sections 91.1015 and 91.1640 or equivalents

   b. LAR 121 Section 121.995 (b) or equivalent

   c. LAR 135 Section 135.565 (c) or equivalent

5. Related ICAO Documents

   a. Annex 6 to the Convention on International Civil Aviation – Operation of Aircraft

   b. Annex 10 to the Convention on International Civil Aviation – Aeronautical telecommunications

   c. Annex 15 to the Convention on International Civil Aviation – Aeronautical information services

   d. ICAO Doc 9613 – Performance-based navigation (PBN) manual

   e. ICAO Doc 4444 – Procedures for air navigation services – Air traffic management

PART 2: INFORMATION ON THE IDENTIFICATION OF AIRCRAFT AND OPERATORS

NAME OF THE OPERATOR: ____

Aircraft manufacturer, model, and series	Registration numbers	Serial numbers	Basic-RNP 1 system Number, manufacturer, and model	RNP specification

DATE OF PRE-APPLICATION MEETING ____

DATE ON WHICH THE APPLICATION WAS RECEIVED ____

DATE ON WHICH THE OPERATOR INTENDS TO BEGIN BASIC-RNP 1 OPERATIONS ______________________

IS THE CAA NOTIFICATION DATE APPROPRIATE? YES _____ NO _____

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PART 3 – OPERATOR APPLICATION (ANNEXES AND DOCUMENTS)

Annex	Title of Annex/Document	Indication of inclusion by the operator	Comments by the Inspector
A	**Operator letter requesting Basic-RNP 1 authorization**		
B	**Airworthiness documents showing aircraft eligibility for Basic-RNP 1.** AFM, AFM revision, AFM supplement, or Type certificate data sheet (TCDS) showing RNP system eligibility for Basic-RNP 1 or less. Statement by the manufacturer.- Aircraft that have a statement by the manufacturer documenting compliance with SRVSOP CA 91-006 criteria or equivalent, meet the performance and functional requirements of said document.		
C	**Aircraft modified to meet Basic-RNP 1 standards. Documentation on aircraft inspection and/or modification, if applicable.** Maintenance records documenting the installation or modification of aircraft systems (*e.g.,* FAA Form 337 – major repairs and alterations).		
D	**Maintenance programme** • For aircraft with established Basic-RNP 1 system maintenance practices, the list of references of the document or programme. • For recently installed Basic-RNP1 systems, the maintenance practices for their review.		
E	**Minimum equipment list (MEL) (only for operators conducting operations based on a MEL):** MEL showing provisions for Basic-RNP 1 systems.		
F	**Training** **1. LAR 91 operators or equivalent: Training method:** Training at home, LAR 142 training centres, or other training courses, course		

Annex	Title of Annex/Document	Indication of inclusion by the operator	Comments by the Inspector
	completion records. **2. LAR 121 and/or 135 operators or equivalent:** Training programmes (training curricula) for flight crews, flight dispatchers, and maintenance personnel.		
G	**Operating policies and procedures** **1. LAR 91 operators or equivalent:** Operations manual (OM) or sections to be attached to the application, corresponding to Basic-RNP 1 operating procedures and policies. **2. LAR 121 and/or 135 operators or equivalent:** Operations manual and checklists.		
H	**Navigation database** **Details of the navigation data validation programme.**		
I	**Withdrawal of Basic-RNP 1 approval** Indication of the need to follow up on navigation error reports submitted and the possibility of withdrawal of Basic-RNP 1 approval.		
J	**Validation flight plan:** Only if required by the CAA.		

CONTENTS OF THE APPLICATION TO BE SUBMITTED BY THE OPERATOR

____ **BASIC-RNP 1 COMPLIANCE DOCUMENTATION OF THE AIRCRAFT/NAVIGATION SYSTEMS**

____ **OPERATING PROCEDURES AND POLICIES**

____ **SECTIONS OF THE MAINTENANCE MANUAL RELATED TO THE BASIC-RNP 1 SYSTEM (if not previously reviewed)**

Note 1: Documents may be grouped in a single folder or may be sent as individual documents.

PART 4: CONTENTS OF THE OPERATOR APPLICATION FOR BASIC-RNP 1 OPERATIONS

#	Contents of the Basic-RNP 1 application by the operator	Reference paragraphs CA 91-006	In what Annexes/Documents of the operator can the application contents be located Note: The operator must update this column to reflect the contents of the application	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
1	**Operator request letter** Statement of intent to obtain Basic-RNP 1 authorization.	Paragraph 9.1.1 b) 1) Appendix 3, Paragraph e)	Annex A		
2	**Description of aircraft equipment.**	Paragraph 9.1.1 b) 2)			
3	**Eligibility of Basic-RNP 1 systems.** Airworthiness documents establishing the eligibility of the Basic-RNP 1 navigation system, its approval status, and a list of the aircraft for which the approval is being requested.	Paragraph 9.1.1 b) 3) Paragraph 8.3	Annex B Annex C		
4	**Training programme** **1. LAR 121 or 135 operators or equivalent: Training programmes:** Operators will develop an initial and periodic training programme for flight crews, flight dispatchers, if applicable, and maintenance personnel. **2. LAR 91 operators or equivalent: Training methods:** The following methods are acceptable for these operators: Training at home, LAR 142	Paragraph 9.1.1 b) 4) (a) Paragraph 11 For maintenance, paragraph 9.1.1 b) 8) Paragraph 9.1.1 b) 4) (b) Paragraph 11	Annex F		

#	Contents of the Basic-RNP 1 application by the operator	Reference paragraphs CA 91-006	In what Annexes/Documents of the operator can the application contents be located Note: The operator must update this column to reflect the contents of the application	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
	training centres, or other training courses.				
5	**Operating procedures** **1. LAR 121 and/or 135 operators or equivalent:** Operations manual and checklists**.** **2. LAR 91 operators or equivalent:** Operations manual or section of the operator application documenting Basic-RNP 1 policies and procedures.	Paragraph 9.1.1 b) 5) (a) Paragraph 10 Paragraph 9.1.1 b) 5) (b) Paragraph 10	Annex G		
6	**Maintenance practices** • For aircraft with established maintenance practices for Basic-RNP 1 navigation systems, the operator will provide document references. • For newly installed Basic-RNP 1 systems, the operator will provide maintenance practices for their review.	Paragraph 8.5 b) Paragraph 9.1.1 b) 7)	Annex D		
7	**Update of the minimum equipment list (MEL)** Applicable to operators conducting operations according to a MEL.	Paragraphs 8.5 a) and 9.1.1 b) 6)	Annex E		
8	**Navigation data validation programme**	Paragraph 9.1.1 b) 9)	Annex F		

#	Contents of the Basic-RNP 1 application by the operator	Reference paragraphs CA 91-006	In what Annexes/Documents of the operator can the application contents be located Note: The operator must update this column to reflect the contents of the application	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
9	**Withdrawal of Basic-RNP 1 approval** Indication of the need for follow-up on the navigation error reports and the possibility of withdrawal of the Basic-RNP 1 approval.	Paragraph 13	Annex H		
10	**Validation flight plan, only if required** The validation flight plan will be presented only if required.	Paragraph 9.1.1 d)	Annex I		

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PART 5 – GUIDE TO DETERMINE THE ELIGIBILITY OF BASIC-RNP 1 AIRCRAFT

#	Topics	Reference paragraphs CA 91-006	Location in the Annexes of the operator	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
1	**Aircraft eligibility requirements for Basic-RNP 1 operations in terminal area** **RNP systems that use GNSS data input.** The following systems installed in the aircraft meet the requirements defined in AC 91-006. This equipment requires evaluation by the manufacturer and operator against all the functional and performance requirement established in that AC:	Paragraph 8.1.3	Annex B		
1a	Aircraft with E/TSO-C129a Class A1 system or E/TSO-C146 () system installed for use of IFR according to FAA AC 20-138 or AC 20-138A	Paragraph 8.1.3 a)			
1b	Aircraft with E/TSO-C129a sensor (Class B or C) installed in a flight management system (FMS) that meets TSO-C115b requirements and is installed for use of IFR according to FAA AC 20-130A	Paragraph 8.1.3 b)			
1c	Aircraft with E/TSO-C145 () sensor installed in an FMS that meets TSO-C115b requirements and is installed for use of IFR according to FAA AC 20-130A or AC 20-138A	Paragraph 8.1.3 c)			

#	Topics	Reference paragraphs CA 91-006	Location in the Annexes of the operator	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
1d	Aircraft with RNP capability certified or approved with equivalent standards.	Paragraph 8.1.3 d)			
2	**Performance, control, and alerting requirements**	Paragraph 8.1.2	Annex B		
3	**Aircraft and systems eligibility for Basic-RNP 1 operations in terminal area** 1. Aircraft with a statement of compliance with SRVSOP CA 91-006 requirements or equivalent document 2. Aircraft with a statement by the manufacturer 3. Modified aircraft. 4. Stand-alone GNSS systems must be approved according to E/TSO-C129a Class A1 or E/TSO-C146 and operational Class 1, 2 or 3 (with no deviation from the functional requirements described in the AC 91-006), and installed for IFR use in accordance with AC 20-138A. 5. Aircraft with E/TSO-C129a sensor(s) Class B or C or E/TSO-C145 sensor(s) and FMS that meet E/TSO-C115b requirements and are installed for IFR use according to FAA AC 20-130A 6. Aircraft/equipment approved under SRVSOP CA 91-003 or equivalent	Paragraph 8.3 Paragraph 8.3.1 Paragraph 8.3.2 Paragraph 8.3.3 Paragraph 8.3.4 Paragraph 8.3.5 Paragraph 8.3.6	Annex B		

#	Topics	Reference paragraphs CA 91-006	Location in the Annexes of the operator	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
	(*e.g.*, FAA AC 90-100A) for use of GNSS, are approved for Basic-RNP 1 operations under this CA. 7. RNP aircraft with P-RNAV approval based on GNSS capability meet the functional requirements of this AC for Basic-RNP 1 operations, such as SIDs y STARs. The GNSS system approved according to E/TSO-C129 and satisfying the step-detection and health word checking contained in E/TSO-C129A, meets P-RNAV performance requirements.	Paragraph 8.3.7			
5	**Functional requirements and their explanation**	Paragraph 8.4 Appendix 1	Annex B		
6	**Maintenance requirements**	Paragraph 8.5	Annex B		
7	**Navigation database** Details of the navigation data validation programme	Paragraph 12 Appendix 2	Annex B		

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PART 6 - BASIC PILOT PROCEDURES FOR BASIC-RNP 1 OPERATIONS

Topics		Reference paragraphs CA 91-006	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
Operating procedures		Paragraph 10	Annex G		
1	**Pre-flight planning**	Paragraph 10.1 a)			
	Operators and pilots intending to conduct Basic-RNP 1 SIDs and STARs must fill out the appropriate boxes in the ICAO flight plan.	Paragraph 10.1 a) 1)			
	On-board navigation data must be current and include appropriate procedures.	Paragraph 10.1 a) 2)			
	The availability of the NAVAID infrastructure required for the intended routes, including any non-RNP contingency, must be confirmed for the period of intended operations, using all available information. Since Annex 10 Volume I requires GNSS integrity (RAIM or SBAS), it is also necessary to confirm apropiate availability of these devices. For aircraft that navigate with SBAS receivers [all TSO-C145 () / C146 () receivers], operators shall confirm appropriate availability of the GNSS RAIM in areas where the SBAS signal is not available.	Paragraph 10.1 a) 3)			
	RAIM (ABAS) availability	Paragraph 10.1 a) 4)			
2	**General operating procedures**	Paragraph 10.1 b)			

	Topics	Reference paragraphs CA 91-006	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	The pilot shall comply with any instruction or procedure identified by the manufacturer, as necessary, to meet the performance requirements of this section.	Paragraph 10.1 b) 1)			
	Operators and pilots shall not request or file Basic-RNP 1 routes, SIDs or STARs, unless they meet all the criteria set forth in this AC. If an aircraft that does not meet these criteria and is cleared by the ATC to conduct a Basic-RNP 1 procedure, the pilot will notify the ATC that it cannot accept such clearance and will request alternate instructions;	Paragraph 10.1 b) 2)			
	At system initialization, pilots must: (a) confirm that the navigation database is current; (b) verify that the aircraft position has been entered correctly; (c) verify the appropriate entry of the assigned ATC route once they receive the initial clearance, and of any subsequent change in route; and (d) ensure that the sequence of WPTs as depicted in their navigation system matches the route drawn in the appropriate charts and the assigned route.	Paragraph 10.1 b) 3)			
	Pilots shall not fly a Basic-RNP 1 procedure, unless it can be retrievable from the on-board	Paragraph 10.1 b) 4)			

	Topics	Reference paragraphs CA 91-006	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	navigation database by its name, and conforms with the procedure in the chart. However, the procedure can be modified afterwards by inserting or deleting specific WPTs in response to ATC clearance. Manual entry or the creation of new WPTs through manual insertion of latitude and longitude or rho/theta values is not permitted. Likewise, pilots must not change any type of WPT from a fly-by WPT to a flyover WPT or *vice versa*.				
	Flight crews shall cross-check the cleared flight plan by comparing charts or other applicable resources to the navigation system text displays and aircraft map displays, as applicable. If required, the exclusion of specific NAVAIDs must be confirmed. A procedure shall not be used if there are any doubts about the validity of the procedure in the navigation database.	Paragraph 10.1 b) 5)			
	A cross-check is not required for conventional NAVAIDs, since the absence of integrity alert is considered sufficient to meet integrity requirements. However, it is suggested that the navigation reasonableness be checked, and any loss of RNP capability must be reported to the ATC.	Paragraph 10.1 b) 6)			
	For Basic-RNP 1 procedures, pilots must use a lateral deviation indicator, an FD or an AP in lateral navigation mode (LNAV). Pilots of aircraft with a lateral deviation display must make sure that the lateral deviation scale is appropriate for the navigation precision associated to the	Paragraph 10.1 b) 7)			

	Topics	Reference paragraphs CA 91-006	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	route/procedure (*e.g.,* full-scale deflection: ± 1 NM for Basic-RNP 1).				
	All pilots are expected to follow the route centreline, as represented on the on-board lateral deviation indicators and/or flight guidance, during all Basic-RNP 1 operations, unless cleared by the ATC to deviate or due to an emergency. For normal operations, the cross-track error/deviation (the difference between the path estimated by the RNP system and the position of the aircraft relative to the path, *e.g.* FTE) must be limited to ± ½ the navigation precision associated with the procedure (*e.g.*, 0.5 NM for basic RNP 1). Small lateral deviations from this requirement are allowed (*e.g.*, overshooting or undershooting the path) during or immediately after a turn, up to a maximum of 1 times the navigation precision (1xRNP) (*e.g.*, 1 NM for basic RNP 1).	Paragraph 10.1 b) 8)			
	If the ATC issues a course assignment that places the aircraft out of the route, the pilot shall not modify the flight plan in the RNP system until a new clearance is received allowing the aircraft to return to the route or until the controller confirms a new route clearance. When the aircraft is not on the published Basic-RNP 1 route, the specified precision requirements do not apply.	Paragraph 10.1 b) 9)			
	Manual selection of functions that limit the banking angle of the aircraft can reduce the ability of the aircraft to maintain its desired track and is not	Paragraph 10.1 b) 10)			

	Topics	Reference paragraphs CA 91-006	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	recommended. Pilots should acknowledge that manual selection of functions that limit the banking angle of the aircraft could reduce their ability to meet ATC path expectations, especially when turns with large banking angles are performed. This cannot be construed as a requirement to deviate from AFM procedures. Pilots must be encouraged to select such functions only within accepted procedures.				
	Pilots operating aircraft that have a barometric vertical navigation system (baro-VNAV) can continue using said system while conducting Basic-RNP 1 SID and STAR procedures. Operators must ensure compliance with all altitude limitations, as published in the procedure, using the barometric altimeter as reference. Use of the barometric vertical navigation capability of the aircraft will be subject to the level of familiarisation and training of the flight crew, and on any other operational approval requirement.	Paragraph 10.1 b) 11)			
	Before starting a Basic-RNP 1 procedure, flight crews must: a) confirm that the correct procedure has been selected. This process includes checking WPT sequence, the reasonableness of track angles, distances, and any other parameter that can be modified by the pilot, such as altitude or speed limitations; and b) for multi-sensor systems, check that the correct	Paragraph 10.1 b) 12)			

	Topics	Reference paragraphs CA 91-006	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	sensor is being used for position computation.				
3	**Aircraft with RNP selection capability** Pilots of aircraft capable of selecting RNP input must select RNP 1 or lower for Basic-RNP 1 SIDs, STARs or procedures.	Paragraph 10.1 c)			
4	**Basic-RNP 1 SID specific requirements**	Paragraph 10.1 d)			
	Before beginning take-off, the pilot must verify that the airborne Basic-RNP 1 system is available and operating correctly, and that the appropriate aerodrome and runway data have been loaded. Before the flight, pilots must verify that the airborne navigation system is operating correctly and that the appropriate runway and departure procedure (including any applicable en-route transition) have been loaded and are properly displayed. Pilots assigned to a Basic-RNP 1 departure procedure and subsequently receive a change of runway, procedure or transition, must verify that the appropriate changes have been entered and are available for navigation before take-off. A final check of proper runway entry and correct route depiction, shortly before take-off, is recommended.	Paragraph 10.1 d) 1)			
	Altitude for engagement the RNAV equipment.- The pilot must be capable of connecting the RNP equipment in order to follow the flight guidance in the RNP lateral navigation mode before reaching 153 m (500 ft) above the aerodrome elevation.	Paragraph 10.1 d) 2)			

Topics		Reference paragraphs CA 91-006	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	Pilots must use an authorised method (lateral deviation indicator/navigation map display/FD/AP) to achieve an appropriate level of performance for Basic-RNP 1.	Paragraph 10.1 d) 3)			
	GNSS aircraft.- When a GNSS is used, the signal must be obtained before starting the take-off roll. For aircraft using E/TSO-C129a equipment, the take-off aerodrome must be loaded into the flight plan in order to achieve the appropriate navigation system monitoring and sensitivity. For aircraft using E/TSO-C145 ()/C146 () equipment, if the departure starts at a runway waypoint (WPT), then the departure aerodrome does not need to be in the flight plan in order to obtain the appropriate monitoring and sensitivity mentioned above. If a Basic-RNP 1 SID extends beyond 30 NM from the aerodrome and a lateral deviation indicator is used, its full-scale sensitivity must be set to a value not greater than 1 NM between 30 NM from the aerodrome and the termination of the Basic-RNP 1 SID.	Paragraph 10.1 d) 4)			
	For aircraft using a lateral deviation display (*e.g.*, a navigation map display), the scale must be adjusted for the Basic-RNP 1 SID and FD or AP must be used.	Paragraph 10.1 d) 5)			
5	**Basic-RNP 1 STAR specific requirements**	Paragraph 10.1 e)			
	Before the arrival phase, the flight crew shall verify	Paragraph 10.1 e) 1)			

	Topics	Reference paragraphs CA 91-006	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	that the correct terminal route has been loaded. The active flight plan shall be checked, comparing the charts to the map display (if applicable) and the multi-function control display unit (MCDU). This includes confirmation of WPT sequence, the reasonableness of track angles and distances, any altitude or speed constraints, and, whenever possible, which are fly-by WPTs and which are flyover WPTs. If required by a route, a check will need to be made to confirm that updating will exclude a particular NAVAID. A route will not be used if there are doubts about its validity in the navigation database.				
	The creation of new WPTs by the flight crew through manual entries into the Basic-RNP 1 system will invalidate any route, and is not permitted.	Paragraph 10.1 e) 2)			
	When contingency procedures require reverting to a conventional arrival route, the flight crew must make the necessary preparations before starting the Basic-RNP 1 procedure.	Paragraph 10.1 e) 3)			
	Modification made to a route in the terminal area may take the form of radar headings or “direct to” clearances. In this sense, the flight crew must be capable of reacting in time. This may include the insertion of tactical WPTs loaded from the database. The flight crew is not allowed to make manual entries or to modify a loaded route, using temporary WPT or fixes not provided in the	Paragraph 10.1 e) 4)			

	Topics	Reference paragraphs CA 91-006	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	database.				
	Pilots must verify that the aircraft navigation system is operating properly and that the correct arrival procedure and runway are properly entered and displayed.	Paragraph 10.1 e) 5)			
	Although a particular method is not mandated, any published altitude and speed constraints must be observed.	Paragraph 10.1 e) 6)			
	Aircraft with E/TSO-C129a GNSS RNP systems: If a Basic-RNP 1 STAR begins beyond 30 NM from the aerodrome and a lateral deviation indicator is used, its full-scale sensitivity must be set to a value not greater than 1 NM before commencing the STAR. For aircraft that use a lateral deviation display (*e.g.*, a navigation map display), the scale must be adjusted to the Basic-RNP 1 STAR and the FD or AP must be used.	Paragraph 10.1 e) 7)			
6	**Contingency procedures**	Paragraph 10.1 f)			
	The pilot must notify the ATC of any loss of RNP capability (integrity alerts or loss of navigation), together with the proposed course of action. If, for any reason, it is not possible to meet the requirements of a Basic-RNP 1 SID or STAR, pilots must notify the ATS as soon as possible. Loss of RNP capability includes any failure or event that causes the aircraft to be unable to meet the Basic-	Paragraph 10.1 f) 1)			

	Topics	Reference paragraphs CA 91-006	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	RNP 1 requirements of the route.				
	In case of a communication failure, the flight crew must continue with the established procedure for loss of communication.	Paragraph 10.1 f) 2)			

SRVSOP contacts:

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Job Aid: Basic-RNP 1
Version: Original
Date: 12/10/2009

APPENDIX E-1

ADVISORY CIRCULAR

AC	**:**	**91-008**
DATE	**:**	**12/10/09**
REVISION	**:**	**1**
ISSUED BY	**:**	**SRVSOP**

SUBJECT: AIRCRAFT AND OPERATORS APPROVAL FOR RNP APPROACH (RNP APCH) OPERATIONS

ADVISORY CIRCULAR

AC	**:**	**91-008**
DATE	**:**	**12/10/09**
REVISION	**:**	**1**
ISSUED BY	**:**	**SRVSOP**

SUBJECT: AIRCRAFT AND OPERATORS APPROVAL FOR RNP APPROACH (RNP APCH) OPERATIONS

1. PURPOSE

This advisory circular (AC) establishes RNP APCH approval requirements (lateral navigation only) for aircraft and operators. The requirements for barometric vertical navigation (baro-VNAV) of a RNP APCH approach are detailed on CA 91-010 (APV/baro-VNAV). Criteria of this AC together with criteria of AC 91-010 establish the requirements for RNP APCH with baro-VNAV operations.

An operator may use other means of compliance, provided they are acceptable for the civil aviation administration (CAA).

Use of the future tense of the verb or use of the term “must” applies to an operator that chooses to meet the criteria established in this AC.

2. SECTIONS RELATED TO THE LATIN AMERICAN AERONAUTICAL REGULATIONS (LARs) OR EQUIVALENT

LAR 91: Sections 91.1015 and 91.1640 or equivalents

LAR 121: Section 121.995 (b) or equivalent

LAR 135: Section 135.565 (c) or equivalent

3. RELATED DOCUMENTS

Annex 6	Aircraft operations
Annex 10	Aeronautical telecommunications
	Volume I: Radio navigation aids
Doc 9613	Performance-based navigation manual (PBN)
Doc 8168	Aircraft operations
	Volume I: Flight procedures
	Volume II: Construction of visual and instrument flight procedures
AMC 20-27	Airworthiness approval and operational criteria for RNP APPROACH (RNP APCH) operations including APV BARO-VNAV operations
FAA AC 90-105	Approval guidance for RNP operations and barometric vertical navigation in the U.S. National Airspace System

4. DEFINITIONS AND ABBREVIATIONS

4.1 Definitions

a) **Primary field of view.-** For the purposes of this AC, the primary field of view is within 15 degrees of the primary line of sight of the pilot.

b) **Navigation specifications**.- A set of aircraft and flight crew requirements needed to support performance based navigation operations within a defined airspace. There are two kinds of navigation specifications:

Required navigation performance (RNP) specification.- A navigation specification based on area navigation that includes the requirement for on-board performance monitoring and alerting, designated by the prefix RNP, e.g., RNP 4, RNP APCH, RNP AR APCH.

Area navigation (RNAV) specification.- A navigation specification based on area navigation that does not include the requirement for on-board performance monitoring and alerting, designated by the prefix RNAV, e.g., RNAV 5, RNAV 2, RNAV 1.

Note 1.- The Performance-based Navigation (PBN) Manual (Doc 9613), Volume II, contains detailed guidance on navigation specifications.

Note 2.- The term RNP as previously defined as "a statement of the navigation performance, necessary for operation within a defined airspace", has been removed from the Annexes to the Convention on International Civil Aviation as the concept of RNP has been overtaken by the concept of PBN. The term RNP in such Annexes is now solely used in context of navigation specifications that require performance monitoring and alerting, e.g., RNP 4 refers to the aircraft and operating requirements, including a 4 NM lateral performance with on board performance monitoring and alerting that are detailed in the PBN Manual (Doc 9613).

c) **Performance based navigation (PBN)**.- Performance based navigation specifies system performance requirements for aircraft operating along an ATS route, on an instrument approach procedure, or in a designated airspace.

Performance requirements are defined in terms of accuracy, integrity, continuity, availability, and functionality needed for the proposed operation in the context of a particular airspace concept.

d) **Area navigation (RNAV)**.- A method of navigation which permits aircraft operation on any desired flight path within the coverage of ground or space-based navigation aids or within the limits of the capabilities of self-contained navigation aids, or a combination of these.

Note.- Area navigation includes performance based navigation as well as other RNAV operations that do not meet the definition of performance based navigation.

e) **RNP operations**.- Aircraft operations using a RNP system for RNP applications.

f) **Waypoint (WPT).-** A specified geographical location used to define an area navigation route or the flight path of an aircraft employing area navigation. Waypoints are identified as either:

Fly-by waypoint.- A waypoint that requires turn anticipation to allow tangential interception of the next segment of a route or procedure.

Flyover waypoint.- A waypoint at which a turn is initiated in order to join the next segment of a route or procedure.

g) **Initial approach fix (IAF).-** Fix that marks the beginning of the initial segment and the end of the arrival segment, if applicable. In RNAV application, this fix is normally defined as a "fly-by fix".

h) **Flight management system (FMS)**.- An integrated system, consisting of an airborne sensor, receiver and computer with both navigation and aircraft performance databases, which provides performance and RNAV guidance to a display and automatic flight control system.

i) **Global positioning system (GPS)**.- The U.S. global navigation satellite system (GNSS) is a satellite based radio navigation system that uses precise distance measurements to determine the position, velocity and time anywhere in the world. The GPS is composed of space, control and user elements. The space element consists of at least 24 satellites in 6 orbiting planes. The control element consists of 5 monitoring stations, 3 ground antennas, and one main control station. The user element consists of antennas and receivers that provide the user with position, speed, and precise time information.

j) **Global navigation satellite system (GNSS)**.- Generic term used by ICAO to define any worldwide position, velocity and time determination system, which consists of one or more main satellite constellations, such as the GPS and the global navigation satellite system (GLONASS), aircraft receivers, and several integrity monitoring systems, including aircraft-based augmentation systems (ABAS), satellite-based augmentation systems (SBAS), such as the wide area augmentation system (WAAS) and ground-based augmentation systems (GBAS), such as the local area augmentation system (LAAS).

Distance information will be provided, at least in the immediate future, by GPS and GLONASS.

k) **RNP system**.- An area navigation system which supports on-board performance monitoring and alerting.

l) **RNP value**.- The RNP value designates the lateral performance requirement associated with a procedure. Examples of RNP values are: RNP 0.3 and RNP 0.15.

m) **Receiver autonomous integrity monitoring (RAIM)**.- Technique used in a GPS receiver/processor to determine the integrity of its navigation signals, using only GPS signals or GPS signals augmented with barometric altitude data. This determination is achieved by a consistency check among redundant pseudo-range measurements. At least one additionally satellite to those required must be available to obtain the navigation solution.

4.2 Abbreviations

a)	AAC	Civil Aviation Administration
b)	ABAS	Aircraft-based augmentation system
c)	AIP	Aeronautical information publication
d)	AP	Autopilot
e)	APCH	Approach
f)	APV	Approach procedure with vertical guidance
g)	APV/baro-VNAV	Approach operations with vertical guidance/Barometric vertical navigation
h)	AR	Authorisation required
i)	AIRAC	Aeronautical information regulation and control
j)	AC	Advisory circular (FAA)
k)	AFM	Aircraft flight manual
l)	AMC	Acceptable means of compliance
m)	ANSP	Air navigation service provider
n)	ATC	Air traffic control
o)	ATS	Air traffic service
p)	baro-VNAV	Barometric vertical navigation
q)	CA	Advisory circular (SRVSOP)
r)	CDI	Course deviation indicator
s)	CDU	Control display unit
t)	DME	Distance measuring equipment
u)	DME/DME	Distance measuring equipment/distance measuring equipment
v)	DME/DME/IRU	Distance measuring equipment/distance measuring equipment/inertial

		reference unit
w)	DTK	Desired track
x)	EASA	European Aviation Safety Agency
y)	EHSI	Enhanced horizontal situation indicator
z)	ETA	Estimated time of arrival
aa)	FAA	United States Federal Aviation Administration
bb)	FAF	Final approach fix
cc)	FD	Flight director
dd)	FDE	Fault detection and exclusion
ee)	FMS	Flight management system
ff)	Fly-by WPT	Fly-by waypoint
gg)	Flyover WPT	Flyover waypoint
hh)	FSD	Maximum deflection
ii)	FTE	Flight technical error
jj)	GBAS	Ground-based augmentation system
kk)	GNSS	Global navigation satellite system
ll)	GLONAS	Global navigation satellite system
mm)	GPS	Global positioning system
nn)	IAF	Initial approach fix
oo)	IAP	Instrument approach procedure
pp)	IFR	Instrument flight rules
qq)	IRU	Inertial reference unit
rr)	LAAS	Local area augmentation system
ss)	LAR	Latin American Aeronautical Regulations
tt)	LNAV	Lateral navigation
uu)	LOA	Letter of authorisation/letter of acceptance
vv)	LP	Localizer performance
ww)	LPV	Localizer performance with vertical guidance
xx)	MAPt	Missed approach point
yy)	MEL	Minimum equipment list
zz)	NAVAIDS	Navigation aids
aaa)	2D navigation	2D area navigation that only uses the capabilities on the horizontal plane
bbb)	NDB	Non-directional beacon
ccc)	NPA	Non-precision approach
ddd)	NSE	Navigation system error
eee)	NOTAM	Notice to airmen

fff)	OACI	International Civil Aviation Organization
ggg)	OCA/H	Obstacle clearance altitude/height
hhh)	OEM	Original equipment manufacturer
iii)	OM	Operations manual
jjj)	OpSpecs	Operational specifications
kkk)	PANS-OPS	Procedures for air navigation services – Aircraft operations
lll)	PBN	Performance-based navigation
mmm)	PDE	Path definition error
nnn)	PF	Pilot flying the aircraft
ooo)	PFD	Primary flight display
ppp)	POH	Pilot operations handbook
qqq)	PM	Pilot monitoring the aircraft
rrr)	PNF	Pilot not flying the aircraft
sss)	RAIM	Receiver autonomous integrity monitoring
ttt)	RF	Constant radius arc to a fix
uuu)	RNAV	Area navigation
vvv)	$RNAV_{(GNSS)}$	GNSS (GPS)-based RNP APCH approaches
www)	RNP	Required navigation performance
xxx)	RNP APCH	Required navigation performance approach
yyy)	RNP AR APCH	Required navigation performance authorization required approach
zzz)	SBAS	Satellite-based augmentation system
aaaa)	SL	Service letters
bbbb)	SOP	Standard operating procedures
cccc)	SRVSOP	Regional Safety Oversight Cooperation System
dddd)	STC	Supplemental type certificate
eeee)	TCDS	Type certificate data sheet
ffff)	TSE	Total system error
gggg)	TSO	Technical standard order
hhhh)	VMC	Visual flight meteorological conditions
iiii)	VNAV	Vertical navigation
jjjj)	VOR	VHF omnidirectional radio range
kkkk)	VPA	Vertical path angle
llll)	WAAS	Wide area augmentation system
mmmm)	WGS	World geodetic system
nnnn)	WPT	Waypoint
oooo)	XTK	Cross-track

5. INTRODUCTION

5.1 According to Doc 9613 of the International Civil Aviation Organization (ICAO) - Performance-based navigation manual (PBN), there are two types of navigation specifications for approach operations: RNP approach (RNP APCH) and RNP authorisation required approach (RNP AR APCH).

5.2 This AC establishes only the requirements for lateral navigation (2D navigation) of RNP APCH approaches designed with straight segments. This navigation specification includes present $RNAV_{(GNSS)}$ or GNSS approaches.

5.3 The requirements for approaches with curved segments or *published arcs,* also known as segments with constant radius arc to a fix *(RF segments),* are specified in AC 91-009 of the Regional Safety Oversight Cooperation System (SRVSOP) – Aircraft and operators approval for RNP authorization required approach operations (RNP AR APCH).

5.4 The criteria for barometric vertical navigation (baro-VNAV) of a RNP APCH approach, are described in SRVSOP AC 91-010 – Aircraft and operators approval for approach operations with vertical guidance/barometric vertical navigation (APV/baro-VNAV).

5.5 According to Annex 6 to the Convention on International Civil Aviation (also known as Chicago Convention), when RNP APCH approaches do not include barometric vertical guidance, they are classified as non-precision approach (NPA) operations. On the other hand, when RNP APCH operations include barometric vertical guidance, they are classified as approach procedures with vertical guidance (APV).

5.6 Baro-VNAV systems are optional capabilities that do not constitute a minimum requirement for flying $RNAV_{(GNSS)}$ or GNSS approaches using the LNAV line of minima.

5.7 Operations with localizer performance (LP) and localizer performance with vertical guidance (LPV) are not covered by this AC and will be the subject of another SRVSOP AC.

5.8 This document also provides general considerations on the approval of stand-alone and multi-sensor aircraft systems, including their functional requirements, accuracy, integrity, continuity of function, and limitations, together with operational considerations.

5.9 Stand-alone and multi-sensor RNP systems that use GNSS (GPS) and that comply with AMC 20-27 of the European Aviation Safety Agency (EASA) and with the advisory circulars (AC) of the United States Federal Aviation Administration (FAA): AC 90-105, AC 20-138A, AC 20-130A or TSO C 115b/ETSO C 115b, meet the ICAO RNP APCH navigation specification.

Note.- *The multi-sensor systems may use other sensors combinations, such as distance measuring equipment/distance measuring equipment (DME/DME) or distance measuring equipment/distance measuring equipment/inertial reference unit (DME/DME/IRU), that provide the navigation performance acceptable for RNP APCH operations; however, such cases are limited due to the increased complexity in the navigation aid (NAVAID) infrastructure requirements and assessment, and are not practical or cost effective for widespread application.*

5.10 The material described in this AC has been developed based on the following document:

- ✓ ICAO Doc 9613, Volume II, Part C, Chapter 5 – Implementing RNP APCH.

5.11 Where possible, this AC has been harmonised with the following guidance documents:

- ✓ EASA AMC 20-27 - Airworthiness approval and operational criteria for RNP APPROACH (RNP APCH) operations including APV BARO-VNAV operations; and
- ✓ FAA AC 90-105 - Approval guidance for RNP operations and barometric vertical navigation in the U.S. National Airspace System.

Note.- *Notwithstanding harmonisation efforts, operators shall note the differences between this AC and the aforementioned documents when requesting an authorisation from the corresponding Administrations.*

6. GENERAL CONSIDERATIONS

6.1 **Navaid infrastructure**

a) The global navigation satellite system (GNSS) is the primary navigation system to support RNP APCH procedures.

b) For baro-VNAV RNP APCH operations, the procedure design is based upon the use of a barometric altimetry by an airborne RNP system whose capabilities support the required operation. The procedure design must take into account the performance and functional capabilities required in SRVSOP AC 91-010 – Aircraft and operators approval for APV/baro-VNAV operations or in equivalent documents.

c) The acceptability of the risk of loss of RNP APCH capability for multiple aircraft due to satellite failure or loss of on-board monitoring and alerting function (for example, spaces with no receiver autonomous integrity monitoring (RAIM) coverage), must be considered by the responsible airspace authority.

6.2 **Obstacle clearance**

6.2.1 **RNP APCH operations without baro-VNAV guidance**

a) Detailed guidance on obstacle clearance is provided by ICAO Doc 8168 (PANS-OPS), Volume II – Construction of visual and instrument flight procedures. The missed approach procedure may be supported by either RNAV or by conventional segments (*e.g.*, segments based on VHF onmidirectional radio range (VOR), distance measuring equipment (DME), or non-directional radio beacon (NDB)).

b) Procedure designs must take into account of the absence of the vertical navigation (VNAV) capability of the aircraft.

6.2.2 **RNP APCH operations with baro-VNAV guidance**

a) Baro-VNAV is applied where vertical guidance and information is provided to the flight crew during instrument approach procedures containing a vertical path defined by a vertical path angle (VPA).

b) Detailed guidance on obstacle clearance is provided in Doc 8168 (PANS-OPS), Volume II – Construction of visual and instrument flight procedures. The missed approach procedure may be supported by either RNAV or conventional segments (*e.g.,* segments based on VOR, DME, NDB).

6.3 **Publications**

a) The instrument approach charts will clearly identify the RNP APCH application as $RNAV_{(GNSS)}$.

b) For RNP APCH operations without baro-VNAV, the procedure design will be based on normal descent profiles, and the charts will identify minimum altitude requirements for each segment, including a lateral navigation obstacle clearance altitude/height (LNAV OCA/H).

c) For RNP APCH operations with baro-VNAV, the charts will follow the standards of Annex 4 to the Convention on International Civil Aviation for the designation of an RNAV procedure where the vertical path is specified by a glide path angle. The chart designation will be consistent with said Annex and a lateral and vertical navigation obstacle clearance altitude/height will be issued (LNAV/VNAV OCA/H).

d) When the missed approach segment is based on conventional means, the navaid facilities or the airborne navigation means that are necessary to conduct the missed approach will be identified in the relevant publications.

e) The navigation information published in the applicable aeronautical information publication (AIP) for the procedures and the supporting NAVAIDs will meet the requirements of Annexes 15 and 4 to the Convention on International Civil Aviation (as appropriate). Procedure charts will provide sufficient data to support navigation data base checking by the flight crew (including waypoint names (WPT), tracks, distances for each segment and the VPA).

f) All procedures will be based on the 1984 World Geodetic Coordinates (WGS 84).

6.4 **Air traffic service (ATS) communication and surveillance**

a) RNP APCH operations do not include specific requirements for communication and ATS surveillance. Adequate obstacle clearance is achieved through aircraft performance and operating procedures. Where reliance is placed on the use of radar to assist contingency procedures, it must be demonstrated that its performance is adequate for this purpose. The radar service requirement will be identified in the AIP.

b) Appropriate radio phraseology will be published for RNP APCH operations.

c) It is expected that Air traffic control (ATC) to be familiar with aircraft VNAV capabilities, as well as with aspects concerning altimetry setting and the effect of temperature that could potentially affect the integrity of baro-VNAV RNP APCH operations.

d) The particular hazards of a terminal and approach area and the impact of contingency procedures following a multiple loss of RNP APCH capability must be assessed.

6.5 **Navigation accuracies associated with the flight phases of a RNP APCH approach**

a) According to ICAO Doc 9613, navigation accuracies associated with the flight phases of a RNP APCH approach are the following:

1)	initial segment:	RNP 1.0
2)	middle segment:	RNP 1.0
3)	final segment:	RNP 0.3
4)	missed approach segment:	RNP 1.0

6.6 **Additional considerations**

a) It will be consider that many aircraft have the capability to execute a holding pattern manoeuvre using an RNP system.

7. DESCRIPTION OF THE NAVIGATION SYSTEM

a) **Lateral navigation (LNAV)**.- In LNAV, the RNP equipment enables the aircraft to be navigated in accordance with appropriate routing instructions along a path defined by WTP held in an on-board navigation database.

Note.- *LNAV is typically a flight guidance systems mode, where the RNP equipment provides path steering commands to the flight guidance system, which then controls flight technical error (FTE) through either manual pilot control with a path deviation display or through coupling to the FD or AP.*

8. AIRWORTHINESS AND OPERATIONAL APPROVAL

8.1 In order to get an RNP APCH authorization, a commercial air transport operator shall obtain two types of approval:

a) an airworthiness approval from the State of registry; (see Article 31 of the Chicago Convention and paragraphs 5.2.3 and 8.1.1 of Annex 6, Part I); and

b) an operational approval from the State of the Operator (see paragraph 4.2.1 and Attachment F to Annex 6, Part I).

8.2 For general aviation operators, the State of registry will determine if the aircraft meets the applicable RNP APCH requirements and will issue the operational authorisation (*e.g.,* a letter of authorization – LOA) (see paragraph 2.5.2.2 of Annex 6, Part II).

8.3 Before submitting the application, operators shall review all the aircraft qualification requirements. Compliance with airworthiness requirements or the installation of the equipment, by themselves do not constitute operational approval.

9. AIRWORTHINESS APPROVAL

9.1 General

a) The following airworthiness criteria are applicable to the installation of RNP systems required for RNP APCH operations:

1) This AC uses FAA AC 20-138/AC 20-138A (GPS stand-alone system) or AC 20-130A (multi-sensors systems) as a basis for the airworthiness approval of an RNP system based on GNSS.

2) For APV/baro-VNAV operations, AC 20-129 will be used, as established in SRVSOP AC 91-010.

9.2 Aircraft and system requirements

a) Aircraft approved to conduct $RNAV_{(GNNS)}$ or GNSS approaches meet the performance and functional requirements of this AC for RNP APCH instrument approaches without radius to fix segments (without RF segments).

b) Aircraft that have a statement of compliance with respect to the criteria contained in this AC or equivalent documents in their flight manual (AFM), AFM supplement, pilot operations handbook (POH), or the operating manual for their avionics meet the performance and functional requirements of this AC.

c) Aircraft that have a statement from the manufacturer documenting compliance with the criteria of this AC or equivalent documents meet the performance and functional requirements of this document. This statement will include the airworthiness basis for such compliance. Compliance with the sensor requirements will have to be determined by the equipment or aircraft manufacturer, while compliance with the functional requirements may be determined by the manufacturer or through an inspection by the operator.

d) If the RNP installation is based on GNSS stand-alone system, the equipment must be approved in accordance with technical standard order (TSO) C129a/ETSO-C129a Class A1 (or subsequent revisions) or with TSO-C146a/ETSO-C146a Class Gamma, Operational Class 1, 2, or 3 (or subsequent revisions) and meet the functionality requirements of this document.

e) If the RNP installation is based on GNSS sensor equipment used in a multi-sensor system (*e.g.,* flight management system (FMS)), the GNSS sensor must be approved in accordance with TSO-C129 ()/ETSO-C129 () Class B1, C1, B3, C3 (or subsequent revisions) or TSO-C145 ()/ETSO-C145 () Class Beta, Operational Class 1, 2 or 3 (or subsequent revisions) and meet the functionality requirements of this document.

f) Multi-sensor systems using GNSS must be approved in accordance with AC 20-130A or TSO-C115b/ETSO-C115b and meet the functionality requirements of this document.

Note 1.- *The GNSS equipment approved in accordance with TSO-C129a/ETSO-C129a must meet the system functions specified in this document. In addition, integrity should be provided through an aircraft-based augmentation system (ABAS). It is recommended that GNSS receivers include the capability of fault detection and exclusion (FDE) to improve continuity of function.*

Note 2.- *Multi-sensor systems that use DME/DME or DME/DME/IRU as the only means of RNP compliance are not authorised to conduct RNP APCH operations.*

9.3 Performance and functional requirements for RNP APCH systems

a) **Accuracy**

1) The total system error (TSE) in the lateral and longitudinal dimensions of the on-board navigation equipment must be within:

(a) ± 1 NM for at least 95 percent of the total flight time in the initial and intermediate approach segments and for the missed approach of a RNP APCH procedure.

***Note.-** There is no specific RNP accuracy requirement for the missed approach if this segment is based on conventional NAVAIDs (VOR, DME, NDB) or on dead reckoning.*

(b) ± 0.3 NM for at least 95 percent of the total flight time in the final approach segment of the procedure.

2) To satisfy the accuracy requirement, the flight technical error (FTE) (95%) shall not exceed:

(a) 0.5 NM in the initial, intermediate, and missed approach segments of a RNP APCH procedure; and

(b) 0.25 NM in the final approach segment of the procedure.

***Note .-** The use of a deviation indicator with 1 NM full-scale deflection (FSD) on the initial, intermediate and missed approach segment and 0.3 NM FSD on the final approach segment is considered to be an acceptable means of compliance. The use of an autopilot or flight director is consider to be an acceptable means of compliance (roll stabilization do not qualify).*

3) An acceptable means of compliance with the accuracy requirements described in the previous paragraphs is to have an RNP system approved for RNP APCH approaches in accordance with the 2D navigation accuracy criteria of FAA AC 20-138, AC 20-138A or AC 20-130A.

b) **Integrity.-** Malfunction of the aircraft navigation equipment that causes the TSE to exceed 2 times the RNP value is classified as a major failure condition under airworthiness regulations (*e.g.,* 10^{-5} per hour). In the horizontal plane (lateral and longitudinal), the system must provide an alert if the accuracy requirement is not met, or if the probability that the TSE exceeds 2 NM for initial, intermediate and missed approach segments or 0.6 NM for the final approach segment is greater than 10^{-5} per hour.

c) **Continuity.-** Loss of the RNP APCH functions is classified as a minor failure condition if the operator can revert to a different navigation system and safely proceed to a suitable airport. If the missed approach procedure is based on conventional NAVAIDs (*e.g.,* VOR, DME, NDB), the associated navigation equipment must be installed and operational. For RNP APCH operations, at least one RNP navigation system is required.

***Note.-** From an operational point of view, the operator must develop contingency procedures in case of loss of the RNP APCH capability during approach.*

d) **Performance monitoring and alerting.-** During operations in the initial, intermediate and the missed approach segments of a RNP APCH procedure, the RNP system or the RNP system in combination with the pilot, shall provide an alert if the accuracy requirement is not met or if the probability that the lateral TSE exceeds 2 NM is greater than 10^{-5}. During operations on the final approach segment, the RNP system or the RNP system in combination with the pilot shall provide an alert if the accuracy requirement is not met or if the probability that the lateral TSE exceeds 0.6 NM is greater than 10^{-5}.

e) **Signal-in-space.-** During operations in the initial, intermediate, and missed approach segments of an RNP APCH procedure, the aircraft navigation equipment shall provide an alert if the probability of signal-in-space errors causing a lateral position error greater than 2 NM exceeds 10^{-7} per hour (Chicago Convention Annex 10, Table 3.7.2.4-1). During operations in the final approach segment of a RNP APCH procedure, the aircraft navigation equipment shall provide an alert if the probability of signal-in-space errors causing a lateral position error greater than 0.6 NM exceeds 10^{-7} per hour (Chicago Convention Annex 10, Table 3.7.2.4-1).

***Note.-** Compliance with the performance monitoring and alerting requirement does not imply an automatic monitor of FTE. The on board performance monitoring and alerting function must consist at least of a navigation system error (NSE) monitoring and alerting algorithm, and a lateral deviation display enabling the flight crew to monitor the FTE. To the extent operational procedures are used to monitor the FTE, the flight crew procedure, equipment characteristics and installation are evaluated for their effectiveness and equivalence as described in the functional requirements and operational procedures. The path definition error (PDE) is considered negligible due to the quality assurance process and flight crew procedures.*

f) **Path definition.-** Aircraft performance is evaluated around the path defined by the published procedure and by document RTCA/DO-236B Sections 3.2.5.4.1 and 3.2.5.4.2

g) **Functional requirements of navigation displays.-** The following navigation displays and functions are required, according to FAA AC 20-130 and AC 20-138 or equivalent advisory material. Navigation data, including a to/from indication and a failure indicator must be displayed on a lateral deviation display (course deviation indicator (CDI), enhanced horizontal situation indicator (EHSI)) and/or a navigation map display. These displays must be used as primary flight instruments for the navigation of the aircraft, manoeuvre anticipation and for failure/status/integrity indication. The aforementioned non-numerical lateral deviation displays must have the following attributes:

1) the displays must be visible to the pilot and located in the primary field of view when looking forward along the flight path.

2) the lateral deviation display scaling must agree with any alerting and annunciation limits.

3) the lateral deviation display must also have an FSD suitable for the current phase of flight and must be based on the TSE requirement. Scales of ± 1 NM for the initial, intermediate, and missed approach segments and ± 0.3 NM for the final segment are acceptable.

4) the scale of the display may be set automatically by default logic or set to a value obtained from a navigation database. The FSD value must be known or must be available for display to the pilot commensurate with approach values.

5) as an alternate means, a navigation map display must provide equivalent functionality to a lateral deviation display with appropriate map scales (scales may be set manually by the pilot) and provide equivalent functionality to a lateral deviation display. To be approved, the navigation map display must show compliance with TSE requirements and be located in the primary field of view of the pilot.

6) the lateral deviation display must be automatically slaved to the RNP computed path. It is recommended that the course selector of the deviation display be automatically slewed to the RNP computed path.

Note.- *This does not apply for installations where an electronic map display contains a graphical display of the flight path and path deviation.*

7) enhanced navigation displays (*e.g., electronic map displays* or enhanced HSI) to improve lateral situational awareness, navigation monitoring and approach verification (flight plan verification) could become mandatory if the RNP installation does not support the display of information necessary for the accomplishment of these crew tasks.

h) **System capabilities.-** The following system capabilities are required as a minimum:

1) the capability to continuously display to the pilot flying (PF) the aircraft, on the primary flight instruments for navigation of the aircraft (primary navigation display), the RNP computed desired path and aircraft position relative to the path. For operations where the required minimum flight crew is two pilots, a means for the pilot not flying (PNF) the aircraft (pilot monitoring (PM)) to verify the desired path and the aircraft position relative to the path must also be provided.

2) a navigation database, containing current navigation data officially promulgated by the CAA, which can be updated in accordance with the aeronautical information regulation and control (AIRAC) cycle and from/into which approach procedures can be retrieved and entered in the RNP system. The stored resolution of the data must be sufficient to achieve the required track keeping accuracy. The database must be protected against pilot modification of the stored data.

3) the means to display the validity period of navigation data to the pilot.

4) the means to retrieve and display data stored in the navigation database relating to individual waypoints and NAVAIDs, to enable the pilot to verify the route to be flown.

5) the capability to load from the database into the RNP system, the whole approach to be flown. The approach must be loaded by its name from the database to the RNP system.

6) the means to display the following items, either in the primary field of view of the pilot or on a

readily accessible display page:

(a) the identification of the active (to) WPT;

(b) the distance and bearing to the active (to) WPT; and

(c) the ground speed or time to the active (to) WPT.

7) the means to display the following items on a readily accessible display page:

(a) the display of distance between the operational flight plan WPTs;

(b) the display of distance to go;

(c) the display of along track distances; and

(d) the active navigation sensor type, if there is another type of sensor in addition to the GNSS sensor.

8) the capability to execute the "direct to" function.

9) the capability for automatic leg sequencing with the display of sequencing to the pilot.

10) the capability to execute RNP instrument approach procedures (IAP) extracted from the on board aircraft database, including the capability to execute flyover and fly-by turns.

11) the capability to automatically execute leg transitions and maintain tracks consistent with the following ARINC 424 path terminators or their equivalent:

(a) initial fix (IF)

(b) track to fix (TF)

(c) direct to fix (DF)

Note.- *Path terminators are defined in ARINC Specification 424 and their application is described in more detail in RTCA documents DO-236B and DO-201A.*

Note.- *Numerical values for tracks must be automatically entered from the RNP system database.*

12) the capability to display an indication of the RNP system failure, including the associated sensors, in the primary field of view of the pilot.

13) the capability to indicate to the flight crew when the NSE alert limit is exceeded (alert provided by the on board performance monitoring and alerting function).

i) **Flight director/autopilot.-** It is recommended that the flight director (FD) and/or autopilot (AP) remain coupled for RNP approaches. FD or AP coupling is mandatory when lateral TSE cannot be demonstrated without these systems. In this case, operational procedures must indicate that FD and/or AP coupling from the RNP system is mandatory for RNP APCH approaches.

j) **Database integrity.-** the navigation database suppliers must comply with RTCA DO-200A. A letter of acceptance (LOA), issued by the appropriate regulatory authority to each one of the participants in the data chain, demonstrates compliance with this requirement. Positive compliance with this requirement will be considered for those Laos Type 2 issued prior to the publication of this AC.

9.4 System eligibility and approval of RNP APCH operations

a) **Introduction.-** The original equipment manufacturer (OEM) or the holder of installation approval for the aircraft (*e.g.,* the holder of the supplementary type certificate (STC)), must demonstrate to the CAA of State of registry or manufacture that it complies with the appropriate provisions of this AC. The approval can be recorded in the documentation of the manufacturer (*e.g.,* service letters (SL), etc.). Provided the CAA accepts manufacturer documentation, need not be recorded in the AFM.

b) **Eligibility for RNP APCH operations.-** Systems that meet the requirements of Paragraph 9.2 of this AC are eligible for RNP APCH operations. Aircraft qualified in accordance with SRVSOP AC 91-009 or equivalent, *e.g.,* FAA AC 90-101 or EASA AMC 20-26 are considered qualified for RNP APCH operations without further examination.

c) **System eligibility for RNP APCH operations**

1) **LNAV Line of minima qualification**

(a) **Stand-alone systems.-** Stand-alone systems that comply with TSO-C129/ETSO-C129 Class A1 or TSO-C146/ETSO-C146 Classes 1, 2, or 3 meet the aircraft qualification requirements for RNP APCH operations using the LNAV line of minima, provided the IFR equipment installations have been performed in accordance with FAA AC 20-138. RNP systems must be approved in accordance with AC 20-138 or equivalent.

Note.- *it is considered that these systems meet the functional and performance requirements set out in Paragraph 9.3 of this AC in the aspects that correspond.*

(b) **Multi-sensor systems.-**

(1) Multi-sensor systems that use TSO-C129/ETSO-C129 Classes B1, B3, C1, or C3 sensors meet the aircraft qualification requirements for RNP APCH operations using the LNAV line of minima, provided:

- the equipment installations meet the criteria of this AC; and
- the associated flight management system (FMS) complies with TSO-C115b/ETSO-C115b and are installed in accordance with FAA AC 20-130.

(2) Multi-sensor systems that use TSO-C145/ETSO-C145 Classes 1, 2, or 3 sensors meet the aircraft qualification requirements for RNP APCH operations using the LNAV line of minima, provided:

- the equipment installations meet the criteria of this AC; and
- are installed in accordance with FAA AC 20-138.

Note.- *it is considered that these systems meet the functional and performance requirements set out in Paragraph 9.3 of this AC in the aspects that correspond.*

2) **LNAV/VNAV Line of minima qualification**

(a) **Stand-alone systems**

(1) Stand-alone TSO-C146/ETSO-C146 Classes 2 or 3 systems meet the aircraft qualification requirements for RNP APCH operations using the LNAV/VNAV line of minima, provided that the installations meet at least the performance and functional requirements of this AC and AC 91-010 or equivalent.

(2) The systems that meet TSO-C129/ETSO-C129 can be used for RNP APCH operations using the LNAV/VNAV line of minima if they meet the criteria of this AC and AC 91-010 or equivalent.

(3) RNP systems must be approved in accordance with FAA AC 20-138 or equivalent, and those systems that utilize conventional baro-VNAV must provide vertical navigation system performance that meets or exceeds the criteria of AC 91-010 or equivalent.

(b) **Multi-sensor systems**

(1) Multi-sensor systems that use TSO-C129/ETSO-C129 Classes B1, B3, C1, or C3 sensors or TSO-C145/ETSO-C145 Classes 1, 2, or 3 sensors meet the aircraft qualification requirements for RNP APCH operations using the LNAV/VNAV line of minima, provided the installations meet the requirements of this AC and AC 91-010 or equivalents.

(2) RNP systems that utilize conventional baro-VNAV must provide a vertical navigation system performance that meets or exceeds the criteria of AC 91-010 or equivalent.

(3) RNP systems must be installed in accordance with FAA AC 20-138 or equivalent and/or the associated FMS must comply with TSO-C115b/ETSO-C115b and must be installed in accordance with AC 20-130 or equivalent.

9.5 Aircraft modification

a) If any system required for RNP APCH operations is modified (*e.g.,* changes in the software or hardware), the aircraft modification must be approved.

b) The operator must obtain a new operational approval that is supported by updated aircraft operational and qualification documentation.

9.6 Continued airworthiness

a) The operators of aircraft approved to perform RNR APCH operations, must ensure the continuity of the technical capacity of them, in order to meet technical requirements established in this AC.

b) Each operator who applies for RNP APCH operational approval shall submit to the CAA of State of registry, a maintenance and inspection program that includes all those requirements of maintenance necessary to ensure that navigation systems continue fulfilling the RNP APCH approval criteria.

c) The following maintenance documents must be revised, as appropriate, to incorporate RNP APCH aspects:

1) Maintenance control manual (MCM);

2) Illustrated parts catalogs (IPC); and

3) Maintenance program.

d) The approved maintenance program for the affected aircrafts should include maintenance practices listed in maintenance manuals of the aircraft manufacturer and its components, and must consider:

1) that equipment involved in the RNP APCH operation should be maintained according to directions given by manufacturer's components;

2) that any amendment or change of navigation system affecting in any way RNP APCH initial approval, must be forwarded and reviewed by the CAA for its acceptance or approval of such changes prior to its implementation; and

3) that any repair that is not included in the approved/accepted maintenance documentation, and that could affect the integrity of navigation performance, should be forwarded to the CAA for acceptance or approval thereof.

e) Within the RNP APCH maintenance documentation should be presented the training program of maintenance personnel, which inter alia, should include:

1) PBN concept;

2) RNP APCH application;

3) equipment involved in a RNP APCH operation; and

4) MEL use.

10. OPERATIONAL APPROVAL

The airworthiness approval, by itself, does not authorise the operator to conduct RNP APCH operations. In addition to the airworthiness approval, the operator must obtain an operational approval confirming that the installation of the specific equipment is consistent with normal and contingency procedures.

10.1 Operational approval requirements

To obtain the RNP APCH authorisation, the operator will take the following steps, taking into account the criteria established in this paragraph and in Paragraphs 10.2 to 10.10 of this AC.

a) *Airworthiness approval*.- Aircraft shall have the corresponding airworthiness approvals as established in Paragraph 9 of this AC.

b) *Application*.- The operator will submit the following documentation to the CAA:

1) *the application to obtain the RNP APCH authorization*;

2) *Aircraft eligibility and qualification documentation*.- Airworthiness documentation showing that the aircraft and system proposed meet the requirements of this AC, as described in Paragraphs 9 and 10.3. To avoid unnecessarily regulatory activity, the determination of eligibility for existing systems should consider acceptance of manufacturer documentation of compliance. Systems qualified for RNP AR APCH operations are considered qualified for RNP APCH operations without further examination.

3) *Type of aircraft and description of the aircraft equipment to be used*.- The operator will provide a configuration list describing in detail the relevant components and the equipment to be used in the operation. The list shall include each manufacturer, model and version of the GPS equipment and the FMS software installed.

4) *Operational procedures and practices*.- Operator manuals shall properly indicate the navigation operating practices and procedures identified in Paragraphs 10.4, 10.6, and 10.7 of this AC. LAR 91 operators shall confirm that they will operate using identified practices and procedures.

5) *Navigation data validation programme*.- Details of the navigation data validation programme are provided in Appendix 1 to this AC.

6) *Training programmes for the flight crew and flight dispatchers*

(a) Commercial operators (e.g. LAR 121 and 135 operators) must provide a training programme addressing the operational practices, procedures and training items related to RNP APCH operations (e.g. initial, upgrade or recurrent training for flight crew and dispatchers).

Note.- *It is not required to establish a separate training program or regime if RNP APCH training, identified in Paragraph 10.8, is already integrated in the operator's training program. However, it must be possible to identify what aspects of RNP APCH are covered within a training program.*

(b) Private operators (e.g. LAR 91 operators) must be familiar with the practices and procedures identified in Paragraph 10.8 "training program" of this AC.

7) Training programme for maintenance personnel.- Operators will send instruction syllabus corresponding to maintenance personnel.

8) *Operations manual (OM) and checklists*

(a) Operations manual and checklists of commercial operators (e.g. LAR 121 and 135 operators) must address information and guidance on the standard operating procedures (SOP) detailed in Paragraph 10.6. The appropriate manuals should contain navigation operating instructions and contingency procedures described in Paragraph 10.7 of this AC, where specified. Manuals and checklists must be submitted for review as part of the approval process.

(b) Private operators (e.g. LAR 91 operators) must operate using the practices and procedures identified in Paragraphs 10.6 and 10.7 "operating procedures and contingency procedures" of this AC.

9) *Maintenance procedures*.- The operator will submit the maintenance procedures containing airworthiness and maintenance instructions for the systems and equipment to be used in the operation. The operator will provide a procedure to remove and restore RNP APCH operational capability in the aircraft.

10) *Minimum equipment list (MEL)*.- The operator will submit any revision to the MEL needed to conduct RNP APCH operations.

c) *Training*.- Once the amendments to manuals, programmes and documents submitted have been accepted or approved, the operator will provide the necessary training to its personnel.

d) *Validation flights*.- The CAA may conduct validation flights if it deems it necessary for safety purposes. Validation flights will be conducted according to Chapter 13, Volume II, Part II of the SRVSOP Operation Inspector Manual (MIO).

e) *Issuance of the authorisation to conduct RNP APCH operations*.- Once the operator has successfully completed the operational approval process, the CAA will issue, as appropriate, the authorisation to the operator to conduct RNP APCH operations.

1) *LAR 91 operators*.- For operators LAR 91, the CAA will issue a letter of authorisation (LOA).

2) LAR 121 and/or 135 operators.- For LAR 121 and/or LAR 135 operators, the CAA will issue the corresponding operational specifications (OpSpecs) reflecting the RNP APCH authorisation.

10.2 Description of the aircraft equipment

c) The operator must establish and have available a configuration list detailing the components and equipment to be used for RNP APCH operations.

d) The list of required equipment shall be established during the operational approval process, taking into account the AFM. This list shall be used for updating the MEL for each type of aircraft that the operator intends to operate.

e) The details of the equipment and its use in accordance with the approach characteristics appear in this AC and in AC 91-010.

10.3 Aircraft qualification documentation

a) *For aircraft currently conducting RNAV (GPS) or GPS approaches under FAA AC 90-94 or equivalent*.- Documentation is not required for aircraft that have an AFM or AFM supplement which states the aircraft is approved to fly RNAV (GPS) or GPS approaches, to the LNAV line of minima.

b) *For aircraft without approval to fly RNAV (GPS) or GPS instrument approach procedures*.- Operators will submit to the CAA the RNP qualification documentation showing compliance with this AC, provided the equipment is properly installed and operated.

Note.- *Before requesting an RNP APCH authorisation, operators shall review all equipment performance requirements. Equipment installation by itself does not guarantee operational approval nor permit its operational use.*

10.4 RNP APCH operational documentation

a) The operator will develop RNP APCH operational documentation for using the equipment, based on the aircraft or avionics manufacturer documentation.

b) The operational documentation of the aircraft or avionics manufacturer will consist of recommended operational procedures and training programmes for the flight crew, in order to assist operators meet the requirements of this AC.

10.5 Acceptance of documentation

a) **New aircraft/equipment (aircraft/equipment in the process of being manufactured or recently manufactured).-** The aircraft/equipment qualification documentation can be approved as part of an aircraft certification project and be reflected in the AFM and related documents.

b) **Aircraft/equipment in service (capacity achieved in service).-** Previous approvals issued to conduct RNAV (GPS) or GPS instrument approaches according to AC 90-94 or equivalent do not require further evaluations. For installations/equipment not eligible to conduct RNAV (GPS) or GPS instrument approaches, the operator will submit aircraft or avionics qualification documentation to the CAA.

c) The relevant CAA organisation will review the RNP APCH application package. Acceptance will be documented by means of a letter to the operator.

10.6 Operating procedures

a) **Pre-flight planning**

1) Operators and pilots planning to conduct RNP APCH operations must file the appropriate flight plan suffixes.

2) At system initialization, pilots must confirm the navigation database is current and includes appropriate procedures. Likewise, pilots must also verify that the aircraft position is correct.

__Note.-__ Navigation databases are expected to be current for the duration of the flight. If the AIRAC cycle changes during the flight (becomes due), the operators and pilots shall establish procedures to ensure the precision of navigation data, including the capacity of navigation facilities to define routes and flight procedures. Traditionally, this has been done by comparing electronic data with printed documents. An acceptable method is to compare aeronautical charts (new and old) in order to verify navigation fixes before dispatch. If an amended letter for the procedure is published, the database must not be used for conducting the operation.

3) Pilots must verify the proper entry of their ATC assigned route once they have received the initial clearance and following any subsequent changes of the route. Likewise, pilots must ensure the WPT sequence depicted by their navigation system matches their assigned route and the route depicted on the appropriate charts.

__Note.-__ Pilots may notice a slight difference between the navigation information portrayed on the chart and the heading shown on the primary navigation display. A difference of 3 degrees or less may be due to a magnetic variation applied by the equipment manufacturer and may be operationally acceptable.

__Note.-__ Manual selection of functions that limit the aircraft bank angle can reduce the aircraft's ability to maintain the desired track and is not recommended.

4) The aircraft RNP capability depends on the aircraft operational equipment. The flight crew must be able to assess the impact of equipment failure on the anticipated RNP APCH operation and take appropriate action. When a flight dispatch is predicated on flying an RNP APCH procedure that requires the use of the AP or FD at the destination and/or alternate aerodrome, the operator must determine that the AP and/or FD are installed and operational.

5) Pilots must ensure that the approaches which may be used for the intended flight (including the approaches in alternates aerodromes):

(a) can be selected from a valid navigation data base (current AIRAC cycle);

(b) have been verified through an appropriate process (navigation database integrity process); and

(c) have not been prohibited by any NOTAM issued by the CAA or by the air navigation service providers or by an operational instruction of the company.

6) Pilots must ensure that there are sufficient means available to fly and land at the destination or alternate aerodrome in case of loss of RNP APCH capability.

7) Operators and flight crews must take account of any NOTAM issued by the CAA or by the ANSP, or by an operational instruction of the company that might adversely affect aircraft system operation or the availability or suitability of the procedures at the destination aerodrome or at any alternate aerodromes.

8) For missed approach procedures based on conventional NAVAIDs (VOR, NDB), pilots must verify that the appropriate airborne equipment required to fly such procedures is installed and

operational in the aircraft. Likewise, they must verify that the associated ground based NAVAIDs are operational.

9) The availability of the NAVAID infrastructure, required for the intended routes and RNP APCH operations, including any non-RNP contingency, must be confirmed for the period of intended operations, using all available information. Since GNSS integrity (receiver autonomous integrity monitoring (RAIM) or satellite-based augmentation system (SBAS) signal) is required by Annex 10, the availability of such signals must also be determined as appropriate. For aircraft navigating with SBAS receivers (all TSO-C145()/C146()/ETSO-C145()/C146()), operators must check appropriate GPS RAIM availability in areas where SBAS signal is unavailable.

10) RAIM prediction must be performed prior to departure.

(a) The predictive capability must account for known and predicted outages of GPS satellites or other impacts on the navigation system's sensors. The prediction programme should not use a mask angle below 5 degrees, as operational experience indicates that satellite signals at low elevations are not reliable. RAIM availability prediction should take into account the latest GPS constellation notices to airmen (NOTAMs) issued by the CAA or by the ANSP, and use the identical algorithm to that used in the airborne equipment, or an algorithm based on assumptions for RAIM prediction that give a more conservative result. The service may be providing by the ANSP, avionics manufacturer, other entities or through an airborne receiver RAIM prediction capability. RAIM availability may be confirmed by using a model-specific RAIM prediction software.

(b) The RAIM availability prediction software does not guarantee the service. The software is rather a tool to assess the expected capability to meet the required navigation performance. Because of unplanned failures of some GPS elements, pilots must realize that RAIM or GPS navigation my be lost while in flight which may require reversion to an alternative means of navigation. Therefore, pilots must assess their capability to navigate to an alternate aerodrome in case of failure of GPS navigation.

(c) In the event of a predicted, continuous loss of RAIM of more than 5 minutes for any part of the intended RNP APCH operation, the flight should be delayed, cancelled, or re-routed where RAIM requirements can be met.

11) For aircraft navigating with SBAS receivers (all TSO-C145/C146/ ETSO-C145/C146 systems), operators shall take into account the latest GPS constellation and SBAS NOTAMs issued by the CAA or ANSP. If the NOTAMs indicate the SBAS signal is not available over the intended flight route, operators should check appropriate GPS RAIM availability.

b) **Prior to commencing the procedure**

1) In addition to normal procedures, prior to commencing the approach (before the initial approach fix (IAF)), the flight crew must verify the correct procedure has been loaded, by comparing said procedure with the approach charts. This check must include:

(a) the WPT sequence;

(b) the integrity of the tracks and distances of the approach legs, the accuracy of the inbound course and the length of the final approach segment.

Note.- *As a minimum, this check could be a simple inspection of a map display that permits the achievement of the objectives of this paragraph.*

2) The flight crew must also check from the publish charts, map display or control display unit (CDU), which WPT are fly-by and which are flyover.

3) For multi-sensor systems, the flight crew must verify during the approach that GNSS sensor is used for position computation.

4) For a RNP system with aircraft-based augmentation system (ABAS) requiring barometric

corrected altitude, the current aerodrome barometric altimeter setting, must be set at the appropriate time and location, consistent with the performance of the flight operation.

5) When the operation is based on ABAS availability, the flight crew must perform a new RAIM availability check if the estimated time of arrival (ETA) is more than 15 minutes different from the ETA used during the flight planning. This check is also processed automatically 2 NM before the final approach fix (FAF) for a TSO-C129a/ ETSO-C129a Class A1 receiver.

6) In the terminal area, ATC tactical interventions may include radar headings, "direct to" clearances which by-pass the initial approach legs, interception of an initial or intermediate approach segment, or the insertion of WPT loaded from the database. In complying with ATC instructions, the flight crew must be aware of the implications for the RNP system.

(a) The manual entry of coordinates into the RNP system by the flight crew for operations within the terminal area is not permitted.

(b) "Direct to" clearances may be accepted up to the intermediate fix (IF), provided that the resulting track change at the IF does not exceed 45º.

Note.- *"Direct to" clearance to the FAF is not acceptable.*

7) The lateral definition of the flight path between the FAF and the missed approach point (MAPt) must not be revised by the flight crew under no circumstances.

c) **During the procedure**

1) Pilots must comply with the instructions or procedures identified by the operator, as necessary, to meet the performance requirements of this AC.

2) Before starting the descent, the aircraft must be established on the final approach course no later than the FAF to ensure obstacle and terrain clearance.

3) Pilots must check that the navigation system is in approach mode within 2 NM prior to the FAF.

Note.- *This check does not apply for certain RNP systems (e.g., for aircraft that have been approved with a demonstrated RNP capability). For such systems, other means are available, including electronic map display, flight guidance mode indications, etc., which clearly indicate to the flight crew that the approach mode is activated.*

4) The appropriate displays must be selected so that the following information can be monitored by the flight crew:

(a) the RNP computed desired track (DTK); and

(b) the aircraft position relative to the path cross track deviation (XTK) for the flight technical error (FTE) monitoring.

5) A RNP APCH procedure must be discontinued:

(a) if the navigation display is announcing a failure (flagged invalid): or

(b) in case of loss of the integrity alerting function; or

(c) if the integrity alerting function is annunciate not available before passing the FAF; or

(d) if the FTE is excessive.

6) A missed approach must be flown in accordance with the published procedure. Use of the RNP system during the missed approach is acceptable, provided:

(a) the RNP system is operational (*e.g.,* there is no loss of function, no NSE alert, no failure indication, etc.).

(b) the whole procedure (including the missed approach) is loaded from the navigation data base.

7) During the RNP APCH procedure, pilots must use a lateral deviation indicator, FD and/or AP in the lateral navigation mode. Pilots of aircraft with lateral deviation indicator (*e.g.*, CDI) must

ensure that lateral deviation indicator scaling (full-scale deflection) is suitable for the navigation accuracy associated with the different procedure segments (*e.g.,* ± 1.0 NM for the initial, intermediate, and missed approach segments, and ± 0.3 NM for the final approach segment).

8) All pilots are expected to maintain procedure centrelines, as depicted by onboard lateral deviation indicators and/or flight guidance during all the approach procedure unless authorized to deviate by ATC or in emergency conditions.

9) For normal operations, the cross-track error/deviation (the difference between the RNP system computed path and the aircraft position relative to the path) must be limited to ± ½ of the navigation accuracy associated with the procedure (*e.g.,* 0.5 NM for the initial, intermediate and missed approach segments and 0.15 NM for the final approach segment). Brief deviations from this standard (*e.g.,* overshoots or undershoots) during and immediately after turns, up to a maximum of one (1) times the navigation accuracy (*e.g.,* 1.0 NM for the initial and intermediate segments), are allowable.

10) When baro-VNAV is used for vertical path guidance during the final approach segment, deviations above and below the baro-VNAV path must not respectively exceed + 100/-50 ft.

11) Pilots must execute a missed approach if the lateral or vertical deviations exceed the criteria of the previous paragraph, unless the pilot has in sight the visual references required to continue the approach.

12) For aircraft requiring two pilots, the flight crew must verify that each pilot's altimeter has the current setting before beginning the final approach of a RNP APCH approach procedure. The flight crew must also observe any operational limitations associated with altimeter setting sources and the latency of checking and setting the altimeters when approaching the FAF.

13) Although the scale should change automatically, the pilots of an aircraft with lateral deviation indicator (*e.g.,* CDI) must make sure that the scale of the lateral deviation indicator (maximum deflection) is consistent with the different segments of the procedure (e.g., ± 1.0 NM for the initial, intermediate, and missed approach segments, and ± 0.3 NM for the final approach segment).

14) RNP APCH procedures require flight crew monitoring of lateral and, if installed, vertical track deviations on the pilot's primary flight displays (PFD) to ensure the aircraft remains within the bounds defined by the procedure.

10.7 Contingency procedures

a) The pilots must notify ATC of any loss of the RNP APCH capability, together with the proposed course of action.

b) If the pilots cannot meet the requirements of a RNP APCH procedure, they must notify the air traffic service (ATS) as soon as possible.

c) The loss of RNP APCH capability includes any failure or event causing the aircraft to no longer satisfy the RNP APCH requirements of the procedure.

d) The operators must develop contingency procedures in order to react safely following the loss of the RNP APCH capability during the approach.

e) In the event of communication failure, the flight crew must continue with the RNP APCH procedure in accordance with the published lost communication procedure.

f) The operator's contingency procedures must address at least the following conditions:

1) failure of the RNP system components, including those affecting lateral or vertical deviation performances (*e.g.,* failures of a GPS sensor, FD or AP); and

2) loss of navigation signal-in-space (loss or degradation of the external signal).

g) The pilot must ensure the capability to navigate and land at an alternate aerodrome if loss of RNP

APCH capacity occurs.

10.8 Training programme

a) The training programme must provide sufficient training on the aircraft's RNP systems (*e.g.,* training in flight simulators, flight training devices or in the aircraft). The training programme will cover at least the following aspects:

1) the information about this AC.

2) the meaning and proper use of RNP systems.

3) the characteristics of the procedures, as determined from chart depiction and textual description.

4) depiction of WPT types (fly-by and flyover waypoints), required path terminators (IF, TF, and DF) and any other types used by the operator as well as associated aircraft flight paths.

5) navigation equipment required to conduct a RNP APCH operation (at least one RNP system based on GNSS).

6) specific information on RNP systems:

(a) automation levels, annunciation modes, changes, alerts, interactions, reversions and degradation;

(b) functional integration with other aircraft systems;

(c) the meaning and appropriateness of route discontinuities, as well as related flight crew procedures;

(d) monitoring procedures for each flight phase;

(e) types of navigation sensors utilized by the RNP and associated systems, prioritization/weighting/logic;

(f) turn anticipation, taking into account the effect of speed and altitude; and

(g) interpretation of electronic displays and symbols.

7) the operating procedures for RNP equipment, as applicable, including how to perform the following actions:

(a) verify currency of aircraft navigation data;

(b) verify successful completion of RNP system self-tests;

(c) initialize RNP system position;

(d) retrieve and fly an RNP APCH procedure;

(e) adhere to speed and/or altitude constraints associated with an approach procedure;

(f) Fly interception of an initial or intermediate segment of an approach following air traffic control (ATC) notification;

(g) verify WPTs and flight plan programming;

(h) fly direct to a WPT;

(i) determine cross-track error/deviation;

(j) insert and delete route discontinuity;

(k) when required by the CAA, perform gross navigation error check using conventional NAVAIDs; and

(l) change destination and alternate aerodromes.

8) the automation levels recommended for the flight phases and workload, including methods to minimize cross-track error to maintain procedure centreline.

9) radio communication phraseology for RNP applications.

10) ability to conduct contingency procedures following RNP system failures.

10.9 Navigation database

a) The operator must obtain the navigation databases from a qualified supplier.

b) Navigation data suppliers must have a letter of acceptance (LOA) in order to process the navigation information (*e.g.,* FAA AC 20-153 or document on the conditions for the issuance of letters of acceptance for navigation data suppliers by the European Aviation Safety Agency – EASA (EASA IR 21 Sub-part G) or equivalent documents). A LOA recognises the data supplier as one whose data quality, integrity, and quality management practices are consistent with the criteria of document DO-200A/ED-76. The database supplier of an operator must have a Type 2 LOA and their respective suppliers must have a Type 1 or 2 LOA. The CAA may accept a LOA issued to the navigation data suppliers or issue its own LOA.

c) The operator must report to the navigation data supplier on the discrepancies that invalidate a procedure, and prohibit the use of the affected procedures by means of a notice to flight crews.

d) Operators should consider the need to conduct periodic verifications of navigation databases to ensure continued compliance with the existing requirements of the quality system or safety management system.

10.10 Follow-up of navigation error reports

a) The operator will establish a process to receive, analyse, and do the follow-up of navigation error reports that will help him determine the appropriate corrective action.

b) Repetitive occurrences of navigation errors attributed to a specific part of the navigation equipment may result in the cancellation of the approval for using the equipment.

c) The information that indicates the potential for repetitive errors may require the modification of the operator's training programme.

d) The information that attributes multiple errors to a particular pilot may require additional training or licence review.

APPENDIX 1

NAVIGATION DATA VALIDATION PROGRAMME

1. INTRODUCTION

The procedure stored in the navigation database defines the aircraft lateral and vertical guidance. The navigation database is updated every 28 days. The navigation data used in each update are critical for the integrity of each RNP APCH procedure. Bearing in mind the reduced obstacle clearance associated to these approaches, the validation of navigation data requires special consideration. This appendix provides guidance on the procedures to be followed by the operator to validate navigation data associated with RNP APCH procedures.

2. DATA PROCESSING

a) In its procedures, the operator will identify the person responsible for the navigation data updating process.

b) The operator must document a process for accepting, verifying, and loading navigation data into the aircraft.

c) The operator must place their documented data process under configuration control.

3. INITIAL DATA VALIDATION

The operator must validate each RNP APCH procedure before flying the procedure in instrument meteorological conditions (IMC) to ensure compatibility with their aircraft and to ensure the resulting paths matches the published procedure. As a minimum, the operator must:

a) compare the navigation data of the procedure or procedures to be loaded on the FMS with a published procedure.

b) validate the loaded navigation data for the procedure, either in a flight simulator or in the aircraft in visual meteorological conditions (VMC). The depicted procedure on the map display must be compared to the published procedure. The entire procedure must be flown to ensure the path can be used, does not have any apparent lateral or vertical path disconnections, and is consistent with the published procedure.

c) once the procedure is validated, a copy of the validated navigation data must be kept and maintained to be compared with subsequent data updates.

4. DATA UPDATING

Whenever the operator receives a navigation data update and before using such data on the aircraft, the update must be compared with the validated procedure. This comparison must identify and resolve any discrepancy in the navigation data. If there are any significant changes (any changes affecting the approach path or performance) to any part of a procedure, or if such changes are verified through initial information data, the operator must validate the amended procedure in accordance with the initial validation of the data.

5. NAVIGATION DATA SUPLIERS

Navigation data suppliers must have a letter of acceptance (LOA) to process these data (*e.g.,* FAA AC 20-153 or document on the conditions for the issuance of letters of acceptance for navigation data suppliers by the European Aviation Safety Agency – EASA (EASA IR 21 Sub-part G) or equivalent document). A LOA recognises the data supplier as one whose data quality, integrity, and quality management practices are consistent with the criteria of document DO-200A/ED-76. The database supplier of an operator must have a Type 2 LOA, and their respective suppliers must have a Type 1 or 2 LOA. The CAA may accept a LOA issued to the navigation data suppliers or issue its own LOA.

6. AIRCRAFT MODIFICATIONS (UP DATE OF THE DATA BASE)

If an aircraft system required for RNP APCH operations is modified (*e.g.,* a change in the software), the operator is responsible for validation of RNP APCH procedures with the navigation database and the modified system. This may be accomplished without any direct evaluation if the manufacturer verifies that the modification has no effect on the navigation database or path computation. If this verification is not done by the manufacturer, the operator must carry out an initial validation of the navigation data with the modified system.

APPENDIX 2

RNP APCH APPROVAL PROCESS

a) The RNP APCH approval process consists of two types of approvals: the airworthiness and the operational approval. Although the two have different requirements, they must be considered within a single process.

b) This process constitutes an orderly method used by the CAAs to ensure that applicants meet the established requirements.

c) The approval process consists of the following phases:

1)	Phase one:	Pre-application
2)	Phase two:	Formal application
3)	Phase three:	Analysis of the documentation
4)	Phase four:	Inspection and demonstration
5)	Phase five:	Approval

d) In *Phase one - Pre-application*, the CAA meets with the applicant or operator (pre-application meeting), who is advised of all the requirements it must meet during the approval process.

e) In *Phase two - Formal application*, the applicant or operator submits the formal application, accompanied by all the relevant documentation, as established in Paragraph 10.1 of this AC.

f) In *Phase three – Analysis of the documentation*, the CAA evaluates the documentation and the navigation system to determine their eligibility and the approval method to be applied with respect to the aircraft. As a result of this review and evaluation, the CAA may accept or reject the formal application together with the documentation.

g) In *Phase four - Inspection and demonstration*, the operator will train its personnel and conduct validation flights, if required.

h) In *Phase five - Approval*, the CAA issues the RNP APCH authorisation once the operator has met the airworthiness and operational requirements. For LAR 121 and 135 operators, the CAA will issue the OpSpecs, and for LAR 91 operators, it will issue a LOA.

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APPENDIX E-2

RNP APCH JOB AID

APLICATION TO CONDUCT RNP APCH OPERATIONS

RNP APCH JOB AID

APLICATION TO CONDUCT RNP APCH OPERATIONS

1. Introduction

This Job Aid was developed by the Latin American Regional Safety Oversight Cooperation System (SRVSOP) to provide States, operators, and inspectors with guidance on the process to be followed by an applicant in order to obtain an RNP APCH authorization.

2. Purpose of the Job Aid

2.1 To give operators and inspectors information on the main RNP APCH reference documents.

2.2 To provide tables showing the contents of the application, the associated reference paragraphs, the place in the application of the operator where RNP APCH elements are mentioned and columns for inspector comments and follow-up on the status of various elements of RNP APCH.

3. Actions Recommended for the Inspector and Operator

Some recommendations for use of the Job Aid follow:

3.1 At the pre-application meeting with the operator, the inspector reviews the "basic events of the RNP APCH approval process" described in Part 1 of this Job Aid, in order to provide an overview of the approval process events.

3.2 The inspector reviews this Job Aid with the operator in order to establish the form and content of the RNP APCH approval application.

3.3 The operator uses this Job Aid as a guide to collect the documents/RNP APCH Job Aides of the RNP APCH application.

3.4 The operator inserts in the Job Aid references showing in what part of its documents are the RNP APCH programme elements located.

3.5 The operator submits the Job Aid and the application to the inspector (documents/Annexes).

3.6 The inspector indicates in the Job Aid whether an item is in compliance or needs corrective action.

3.7 The inspector informs the operator as soon as possible when a corrective action by the operator is required.

3.8 The operator provides the inspector with the revised material when so requested.

3.9 The CAA provides the operator with the operational specifications (OpSpecs) or a letter of authorisation (LOA), as applicable, when the tasks and documents have been completed.

4. Structure of the Job Aid

5. Main Sources of Documents, Information, and Contacts

To access the RNP APCH, enter to the Web page of the ICAO/SAM Regional Office (www.lima.icao.int) under the SRVSOP link.

6. Main Reference Documents

Reference documents	Titles
Annex 6	Operation of aircraft
ICAO Doc 9613	Performance-based navigation (PBN) manual
FAA AC 90-105 Appendix 1	Qualification criteria for RNP approach operations
EASA AMC 20-27	Airworthiness approval and operational criteria for RNP APPROACH (RNP APCH) operations including APV BARO-VNAV operations
FAA AC 20-130A	Airworthiness approval of navigation or flight management systems integrating multiple navigation sensors
FAA AC 20-138A	Airworthiness approval of Global navigation satellite system (GNSS) equipment
TSO-C115b	Airborne area navigation equipment using multi-sensor inputs
TSO-C129a	Airborne supplemental navigation equipment using the global positioning system (GPS)
TSO-C145a	Airborne navigation sensors using the global positioning system (GPS) augmented by the wide area augmentation system (WAAS)
TSO-C146a	Stand-Alone airborne navigation equipment using the global positioning system (GPS) augmented by the wide area augmentation system (WAAS)

PART 1: GENERAL INFORMATION

Basic events in RNP APCH approval process

	Action by the operator	Action by the CAA
1	Establishes the need to obtain the RNP APCH authorization.	
2	Reviews the AFM, AFM supplement or Type Certificate Data Sheet (TCDS), or other appropriate documents (*e.g.,* service bulletins (SB), service letters (SL), etc.) to determine the eligibility of the aircraft for RNP APCH operations. The operator contacts the aircraft or avionics manufacturer, if necessary, to confirm RNP APCH eligibility of the aircraft.	
3	Contacts the CAA to schedule a pre-application meeting to discuss the operational approval requirements.	
4		During the pre-application meeting, establishes: • the form and contents of the application; • the documents that support RNP APCH approval • the date in which the application will be submitted for evaluation • if necessary, conduct a validation flight observed by the CAA
5	Submits the application at least 60 days in advance of the planned star of RNP APCH operations.	
6		Reviews operator submissions
7	Once the amendments to manuals, programmes, and documents have been approved or accepted, provides training to flight crews, flight dispatchers, and maintenance personnel, and conducts a validation flight, if required by the CAA.	Only if required, participates in the validation flight.
8		Once the operational and airworthiness requirements have been met, issues the operational approval in the form of OpSpecs for LAR 121 or 135 or equivalents, or an LOA for LAR 91 or equivalents, as appropriate.

Notes related to the approval process

1. **Responsible authority**

   a. **Commercial air transport (LAR 121 and/or 135 regulations or equivalent). -** The **State of registry** determines that the aircraft meets the airworthiness requirements. The **State of the operator** issues the RNP APCH approval (*e.g.,* OpSpecs).

   b. **General Aviation (LAR 91 regulations or equivalent).-** The **State of registry** determines that the aircraft meets airworthiness requirements and issues the operational approval (*e.g.,* an LOA).

2. The CAA does not need to issue an LOA or equivalent document for each individual area of operation in the case of LAR 91 operators.

3. LAR 121 and/or 135 operators with RNP APCH approval must list this approval in the OpSpecs.

4. Related sections of the Latin American Aeronautical Regulations (LAR) or equivalent regulations

   a. LAR 91 Sections 91.1015 and 91.1640 or equivalent

   b. LAR 121 Section 121.995 (b) or equivalent

   c. LAR 135 Section 135.565 (c) or equivalent

5. Related ICAO Documents

   a. Annex 6 to the Convention on International Civil Aviation – Operation of aircraft

   b. Annex 10 to the Convention on International Civil Aviation – Aeronautical telecommunications

   c. Annex 15 to the Convention on International Civil Aviation – Aeronautical information services

   d. ICAO Doc 9613 – Manual on performance-based navigation (PBN)

   e. ICAO Doc 4444 – Procedures for air navigation services – Air traffic management

PART 2: INFORMATION ON THE IDENTIFICATION OF AIRCRAFT AND OPERATORS

NAME OF THE OPERATOR: ____

Aircraft manufacturer, model and series	Registration numbers	Serial numbers	RNP APCH system Number, manufacturer, and model	RNP specification

DATE OF PRE-APPLICATION MEETING ____

DATE ON WHICH THE APPLICATION WAS RECEIVED ____

DATE ON WHICH THE OPERATOR INTENDS TO BEGIN RNP APCH OPERATIONS ______________________

IS THE CAA NOTIFICATION DATE APPROPRIATE? YES _____ NO _____

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PART 3 – OPERATOR APPLICATION (ANNEXES AND DOCUMENTS)

Annex	Title of Annex/document	Indication of inclusion by the operator	Comments by the Inspector
A	**Operator letter requesting RNP APCH authorization**		
B	**Airworthiness documents showing aircraft eligibility for RNP APCH.** AFM, AFM revision, AFM supplement, or Type certificate data sheet (TCDS) showing that the RNP navigation system is eligible for RNP APCH. Manufacturer statement.- Aircraft with a manufacturer statement documenting compliance with SRVSOP CA 91-008 criteria or equivalent, meet the performance and functional requirements of said document.		
C	**Aircraft modified to meet RNP APCH standards. Documentation on aircraft inspection and/or modification, if applicable.** Maintenance records documenting the installation or modification of aircraft systems (*e.g.,* FAA Form 337 – major repairs and alterations).		
D	**Maintenance programme** • For aircraft with established maintenance practices for RNP APCH systems, the list of references of the document or programme. • For recently installed RNP APCH systems, the maintenance procedures for their review.		
E	**Minimum equipment list (MEL) (only for operators conducting operations based on a MEL):** MEL showing provisions for RNP APCH systems.		
F	**Training** **1. LAR 91 operators or equivalent: Training methods:** Training at home, LAR 142 training centres, or other training courses, course completion		

Annex	Title of Annex/document	Indication of inclusion by the operator	Comments by the Inspector
	records. **2. LAR 121 and/or 135 operators or equivalent:** Training programmes (training curricula) for flight crews, flight dispatchers, and maintenance personnel.		
G	**Operating policies and procedures** **1. LAR 91 operators or equivalent:** Operations manual (OM) or sections to be attached to the application, corresponding to RNP APCH operating procedures and policies. **2. LAR 121 and/or 135 operators or equivalent:** Operations manual and checklists.		
H	**Navigation database** Details of the navigation database validation programme		
I	**Withdrawal of RNP APCH approval** Indication of the need to follow up on navigation error reports submitted and the possibility of withdrawal of RNP APCH approval.		
J	**Validation flight plan** Only if required by the CAA.		

CONTENTS OF THE APPLICATION TO BE SUBMITTED BY THE OPERATOR

____ **DOCUMENTATION SHOWING RNP APCH COMPLIANCE OF THE AIRCRAFT/NAVIGATION SYSTEMS**

____ **OPERATING PROCEDURES AND POLICIES**

____ **SECTIONS OF THE MAINTENANCE MANUAL RELATED TO THE RNP APCH SYSTEM (if not previously reviewed)**

Note 1: Documents may be grouped in a single folder or may be sent as individual documents.

PART 4: CONTENTS OF THE OPERATOR APPLICATION FOR RNP APCH OPERATIONS

#	Contents of the RNP APCH application by the operator	Reference paragraphs CA 91-009	In what Annexes/Documents of the operator can the application contents be located	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
1	**Operator request letter** Statement of intent to obtain RNP APCH authorization.	Paragraph 10.1 b) 1) Appendix 2, Paragraph e)	Annex A		
2	**Type of aircraft and description of aircraft equipment** A configuration list with details of the relevant components and the equipment to be used in the operation. The list shall include each manufacturer, model and version of the equipment and software of the installed FMS.	Paragraph 10.1 b) 1) Paragraph 10.2			
3	**Aircraft and navigation system eligibility and qualification for RNP APCH** Airworthiness documents which establish aircraft and navigation system eligibility for RNP APCH operations, their approval status and a list with the aircraft for which the approval is requested.	Paragraph 10.1 b) 2) Paragraphs 9.2 , 9.4 and 10.3	Annex B Annex C		
4	**Training programmes** a) **LAR 121 or 135 operators or equivalent: Training programmes:**	Paragraph 10.1 b) 6) Paragraphs 10.8	Annex F		

#	Contents of the RNP APCH application by the operator	Reference paragraphs CA 91-009	In what Annexes/Documents of the operator can the application contents be located	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
	Operators will develop an initial and periodic training programme for flight crews, flight dispatchers and maintenance personnel. b) **LAR 91 operators or equivalent: Training methods:** The following methods are acceptable for these operators: Training at home, LAR 142 training centres, or other training courses**.**	For maintenance Paragraph 10.1 b(7)			
5	**Operations Manual (OM) and checklists** a) **LAR 121 and/or 135 operators or equivalent:** Operations manual and checklists. b) **LAR 91 operators or equivalent:** Operations manual or section of the operator application documenting RNP APCH policies and procedures.	Paragraph 10.1 b) 4) and 8) Paragraphs 10.6 and 10.7			
6	**Maintenance procedures** • For aircraft with established maintenance practices for RNP APCH navigation systems, the operator will provide document references. • For newly installed RNP APCH systems, the operator will provide	Paragraph 10.1 b) 9)	Annex D		

#	Contents of the RNP APCH application by the operator	Reference paragraphs CA 91-009	In what Annexes/Documents of the operator can the application contents be located	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
	maintenance practices for review.				
7	**Minimum equipment list (MEL)** The operator will submit any revision to the MEL, necessary to carry out RNP APCH operations.	Paragraph 10.1 b) 10)	Annex E		
8	**Navigation data validation programme** Details of the navigation data validation programme.	Paragraph 10.1 b) 5)	Annex F		
9	**Withdrawal of RNP APCH operation authorization** Indication of the need for follow-up on the navigation error reports and the potential of withdrawal of the RNP APCH approval.				
10	**Validation test plan, only if required** The validation flight plan will be presented only if required	Appendix 7, paragraph b) 14)	Annex I		

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PART 5 – GUIDE TO DETERMINE THE ELIGIBILITY OF RNP APCH AIRCRAFT

#	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
1	**Aircraft and system requirements**	Paragraph 9.2	Annex B		
	a) Aircraft approved to conduct RNAV $_{(GNNS)}$ or GNSS approaches.	Paragraph 9.2 a)			
	b) Aircraft that have a statement of compliance with respect to the criteria contained in the AC 91-008 or equivalent document in their flight manual (AFM), AFM supplement, pilot operations handbook (POH), or in the avionics operating manual.	Paragraph 9.2 b)	Annex B		
	c) Aircraft that have a statement from the manufacturer documenting compliance with the criteria of the AC 91-008 or equivalent document.	Paragraph 9.2c)	Annex B		
	d) RNP installation based on GNSS stand-alone system	Paragraph 9.2 d)			
	e) RNP installation is based on GNSS sensor equipment used in a multi-sensor system	Paragraph 9.2 e)			

#	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
	f) Multi-sensor systems using GNSS	Paragraph 9.2 f)			
2	**Eligibility for RNP APCH operations**	Paragraph 9.4 b)			
	a) Systems that meet the requirements of Paragraph 1 above are eligible for RNP APCH operations	Paragraph 9.4 b)			
	b) Aircraft qualified in accordance with SRVSOP AC 91-009 or equivalent, *e.g.*, FAA AC 90-101 or EASA AMC 20-26 is considered qualified for RNP APCH operations without further examination.	Paragraph 9.4 b)			
3	**System eligibility for RNP APCH operations**	Paragraph 9.4 c)			
	a) LNAV Line of minima qualification	Paragraph 9.4 c) 1)			
	1) Stand-alone systems	Paragraph 9.4 c) 1) (a)			
	2) Multi-sensor systems	Paragraph 9.4 c) 1) (b)			
	b) LNAV/VNAV Line of minima qualification	Paragraph 9.4 c) 2)			
	1) Stand-alone systems	Paragraph 9.4 c) 2) (a)			
	2) Multi-sensor systems	Paragraph 9.4 c) 2) (b)			

#	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
4	**Modified aircraft**	Paragraph 9.5	Annex B		
5	**Performance an functional requirements for RNP APCH systems**	Paragraph 9.3			
5	**Navigation database** Details of the navigation data validation programme.	Paragraph 10.9 Appendix 1	Annex B		

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PART 6 - BASIC PILOT PROCEDURES FOR RNP APCH OPERATIONS

	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	Operating procedures	Paragraph 10.6	Annex G		
1	**Pre-flight planning**	Paragraph 10.6 a)			
	Operators and pilots planning to conduct RNP APCH operations must file the appropriate flight plan suffixes.	Paragraph 10.6 a) 1)			
	At system initialization, pilots must confirm the navigation database is current and includes appropriate procedures. Likewise, pilots must also verify that the aircraft position is correct.	Paragraph 10.6 a) 2)			
	Pilots must verify the proper entry of their ATC assigned route once they have received the initial clearance and following any subsequent changes of the route. Likewise, pilots must ensure the WPT sequence depicted by their navigation system matches their assigned route and the route depicted on the appropriate charts.	Paragraph 10.6 a) 3)			
	The aircraft RNP capability depends on the aircraft operational equipment. The flight crew must be able to assess the impact of equipment failure on the anticipated RNP APCH operation and take appropriate action. When a flight dispatch is predicated on flying an RNP APCH procedure that requires the use of the AP or FD at the destination	Paragraph 10.6 a) 4)			

	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	and/or alternate aerodrome, the operator must determine that the AP and/or FD are installed and operational.				
	Pilots must ensure that the approaches which may be used for the intended flight (including the approaches in alternates aerodromes): a) can be selected from a valid navigation data base (current AIRAC cycle); b) have been verified through an appropriate process (navigation database integrity process); and c) have not been prohibited by any NOTAM issued by the CAA or by the air navigation service providers or by an operational instruction of the company.	Paragraph 10.6 a) 5)			
	Pilots must ensure that there are sufficient means available to fly and land at the destination or alternate aerodrome in case of loss of RNP APCH capability.	Paragraph 10.6 a) 6)			
	Operators and flight crews must take account of any NOTAM issued by the CAA or by the ANSP, or by an operational instruction of the company that might adversely affect aircraft system operation or the availability or suitability of the procedures at the destination aerodrome or at any alternate aerodromes.	Paragraph 10.6 a) 7)			

Topics		Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	For missed approach procedures based on conventional NAVAIDs (VOR, NDB), pilots must verify that the appropriate airborne equipment required to fly such procedures is installed and operational in the aircraft. Likewise, they must verify that the associated ground based NAVAIDs are operational.	Paragraph 10.6 a) 8)			
	The availability of the NAVAID infrastructure, required for the intended routes and RNP APCH operations, including any non-RNP contingency, must be confirmed for the period of intended operations, using all available information. Since GNSS integrity (receiver autonomous integrity monitoring (RAIM) or satellite-based augmentation system (SBAS) signal) is required by Annex 10, the availability of such signals must also be determined as appropriate. For aircraft navigating with SBAS receivers (all TSO-C145()/C146()/ ETSO-C145()/C146()), operators must check appropriate GPS RAIM availability in areas where SBAS signal is unavailable.	Paragraph 10.6 a) 9)			
	RAIM prediction must be performed prior to departure. a) The predictive capability must account for known and predicted outages of GPS satellites or other impacts on the navigation system's sensors. The prediction programme should not use a mask angle below 5 degrees, as operational experience indicates	Paragraph 10.6 a) 10)			

Topics		Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	that satellite signals at low elevations are not reliable. RAIM availability prediction should take into account the latest GPS constellation notices to airmen (NOTAMs) issued by the CAA or by the ANSP, and use the identical algorithm to that used in the airborne equipment, or an algorithm based on assumptions for RAIM prediction that give a more conservative result. The service may be providing by the ANSP, avionics manufacturer, other entities or through an airborne receiver RAIM prediction capability. RAIM availability may be confirmed by using a model-specific RAIM prediction software. b) The RAIM availability prediction software does not guarantee the service. The software is rather a tool to assess the expected capability to meet the required navigation performance. Because of unplanned failures of some GPS elements, pilots must realize that RAIM or GPS navigation my be lost while in flight which may require reversion to an alternative means of navigation. Therefore, pilots must assess their capability to navigate to an alternate aerodrome in case of failure of GPS navigation. c) In the event of a predicted, continuous loss of RAIM of more than 5 minutes for any part of the intended RNP APCH operation, the flight should be delayed, cancelled, or re-routed				

	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	where RAIM requirements can be met.				
	For aircraft navigating with SBAS receivers (all TSO-C145/C146/ ETSO-C145/C146 systems), operators shall take into account the latest GPS constellation and SBAS NOTAMs issued by the CAA or ANSP. If the NOTAMs indicate the SBAS signal is not available over the intended flight route, operators should check appropriate GPS RAIM availability.	Paragraph 10.6 a) 11)			
2	**Prior to commencing the procedure**	Paragraph 10.6 b)			
	In addition to normal procedures, prior to commencing the approach (before the initial approach fix (IAF)), the flight crew must verify the correct procedure has been loaded, by comparing said procedure with the approach charts. This check must include: a) the WPT sequence; b) the integrity of the tracks and distances of the approach legs, the accuracy of the inbound course and the length of the final approach segment.	Paragraph 10.6 b) 1)			

Topics		Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	The flight crew must also check from the publish charts, map display or control display unit (CDU), which WPT are fly-by and which are flyover.	Paragraph 10.6 b) 2)			
	For multi-sensor systems, the flight crew must verify during the approach that GNSS sensor is used for position computation.	Paragraph 10.6 b) 3)			
	For a RNP system with aircraft-based augmentation system (ABAS) requiring barometric corrected altitude, the current aerodrome barometric altimeter setting, must be set at the appropriate time and location, consistent with the performance of the flight operation.	Paragraph 10.6 b) 4)			
	When the operation is based on ABAS availability, the flight crew must perform a new RAIM availability check if the estimated time of arrival (ETA) is more than 15 minutes different from the ETA used during the flight planning. This check is also processed automatically 2 NM before the final approach fix (FAF) for a TSO-C129a/ ETSO-C129a Class A1 receiver.	Paragraph 10.6 b) 5)			
	In the terminal area, ATC tactical interventions may include radar headings, “direct to” clearances which by-pass the initial approach legs, interception of an initial or intermediate approach segment, or the insertion of WPT loaded from the database. In complying with ATC instructions, the flight crew must be aware of the implications for the RNP	Paragraph 10.6 b) 6)			

	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	system. a) The manual entry of coordinates into the RNP system by the flight crew for operations within the terminal area is not permitted. b) "Direct to" clearances may be accepted up to the intermediate fix (IF), provided that the resulting track change at the IF does not exceed 45º.				
	The lateral definition of the flight path between the FAF and the missed approach point (MAPt) must not be revised by the flight crew under no circumstances.	Paragraph 10.6 b) 7)			
3	**During the procedure**	Paragraph 10.6 c)			
	Pilots must comply with the instructions or procedures identified by the operator, as necessary, to meet the performance requirements of this AC.	Paragraph 10.6 c) 1)			
	Before starting the descent, the aircraft must be established on the final approach course no later than the FAF to ensure obstacle and terrain clearance.	Paragraph 10.6 c) 2)			
	Pilots must check that the navigation system is in approach mode within 2 NM prior to the FAF.	Paragraph 10.6 c) 3)			

	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	The appropriate displays must be selected so that the following information can be monitored by the flight crew: a) the RNP computed desired track (DTK); and b) the aircraft position relative to the path cross track deviation (XTK) for the flight technical error (FTE) monitoring.	Paragraph 10.6 c) 4)			
	A RNP APCH procedure must be discontinued: a) if the navigation display is announcing a failure (flagged invalid): or b) in case of loss of the integrity alerting function; or c) if the integrity alerting function is annunciate not available before passing the FAF; or d) if the FTE is excessive.	Paragraph 10.6 c) 5)			
	A missed approach must be flown in accordance with the published procedure. Use of the RNP system during the missed approach is acceptable, provided: a) the RNP system is operational (*e.g.,* there is no loss of function, no NSE alert, no failure indication, etc.). b) the whole procedure (including the missed approach) is loaded from the navigation data base.	Paragraph 10.6 c) 6)			

Topics		Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	During the RNP APCH procedure, pilots must use a lateral deviation indicator, FD and/or AP in the lateral navigation mode. Pilots of aircraft with lateral deviation indicator (*e.g.*, CDI) must ensure that lateral deviation indicator scaling (full-scale deflection) is suitable for the navigation accuracy associated with the different procedure segments (*e.g.,* ± 1.0 NM for the initial, intermediate, and missed approach segments, and ± 0.3 NM for the final approach segment).	Paragraph 10.6 c) 7)			
	All pilots are expected to maintain procedure centrelines, as depicted by onboard lateral deviation indicators and/or flight guidance during all the approach procedure unless authorized to deviate by ATC or in emergency conditions.	Paragraph 10.6 c) 8)			
	For normal operations, the cross-track error/deviation (the difference between the RNP system computed path and the aircraft position relative to the path) must be limited to ± ½ of the navigation accuracy associated with the procedure (*e.g.,* 0.5 NM for the initial, intermediate and missed approach segments and 0.15 NM for the final approach segment). Brief deviations from this standard (*e.g.,* overshoots or undershoots) during and immediately after turns, up to a maximum of one (1) times the navigation accuracy (*e.g.,* 1.0 NM for the initial and	Paragraph 10.6 c) 9)			

Topics		Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	intermediate segments), are allowable.				
	When baro-VNAV is used for vertical path guidance during the final approach segment, deviations above and below the baro-VNAV path must not respectively exceed + 100/-50 ft.	Paragraph 10.6 c) 10)			
	Pilots must execute a missed approach if the lateral or vertical deviations exceed the criteria of the previous paragraph, unless the pilot has in sight the visual references required to continue the approach.	Paragraph 10.6 c) 11)			
	For aircraft requiring two pilots, the flight crew must verify that each pilot's altimeter has the current setting before beginning the final approach of a RNP APCH approach procedure. The flight crew must also observe any operational limitations associated with altimeter setting sources and the latency of checking and setting the altimeters when approaching the FAF.	Paragraph 10.6 c) 12)			
	Although the scale should change automatically, the pilots of an aircraft with lateral deviation indicator (*e.g.,* CDI) must make sure that the scale of the lateral deviation indicator (maximum deflection) is consistent with the different segments of the procedure (e.g., ± 1.0 NM for the initial, intermediate, and missed approach segments, and ± 0.3 NM for the final approach segment).	Paragraph 10.6 c) 13)			

	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	RNP APCH procedures require flight crew monitoring of lateral and, if installed, vertical track deviations on the pilot's primary flight displays (PFD) to ensure the aircraft remains within the bounds defined by the procedure.	Paragraph 10.6 c) 14)			
4	**Contingency procedures**	Paragraph 10.7			
	The pilots must notify ATC of any loss of the RNP APCH capability, together with the proposed course of action.	Paragraph 10.7 a)			
	If the pilots cannot meet the requirements of a RNP APCH procedure, they must notify the air traffic service (ATS) as soon as possible.	Paragraph 10.7 b)			
	The loss of RNP APCH capability includes any failure or event causing the aircraft to no longer satisfy the RNP APCH requirements of the procedure.	Paragraph 10.7 c)			
	The operators must develop contingency procedures in order to react safely following the loss of the RNP APCH capability during the approach.	Paragraph 10.7 d)			
	In the event of communication failure, the flight crew must continue with the RNP APCH procedure in accordance with the published lost	Paragraph 10.7 e)			

	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	communication procedure.				
	The operator's contingency procedures must address at least the following conditions: a) failure of the RNP system components, including those affecting lateral or vertical deviation performances (*e.g.,* failures of a GPS sensor, FD or AP); and b) loss of navigation signal-in-space (loss or degradation of the external signal).	Paragraph 10.7 f)			
	The pilot must ensure the capability to navigate and land at an alternate aerodrome if loss of RNP APCH capacity occurs.	Paragraph 10.7 g)			

SRVSOP contacts:

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Job Aid: RNP APCH
Version: Original
Date: 12/10/2009

APPENDIX F-1

ADVISORY CIRCULAR

AC	**:**	**91-009**
DATE	**:**	**12/10/09**
REVISION	**:**	**1**
ISSUED BY	**:**	**SRVSOP**

SUBJECT: AIRCRAFT AND OPERATORS APPROVAL FOR RNP AUTHORIZATION REQUIRED APPROACH (RNP AR APCH) OPERATIONS

ADVISORY CIRCULAR

AC	**:**	**91-009**
DATE	**:**	**12/10/09**
REVISION	**:**	**1**
ISSUED BY	**:**	**SRVSOP**

SUBJECT: AIRCRAFT AND OPERATORS APPROVAL FOR RNP AUTHORIZATION REQUIRED APPROACH (RNP AR APCH) OPERATIONS

1. PURPOSE

This advisory circular (AC) provides acceptable means of compliance (AMC) concerning aircraft and operators approval for RNP authorization required approach (RNP AR APCH) operations.

An operator may use other means of compliance, provided they are acceptable for the civil aviation administration (CAA).

Use of the future tense of the verb or use of the term “must” applies to an applicant or operator that chooses to meet the criteria established in this AC.

2. RELATED SECTIONS OF THE LATIN AMERICAN AERONAUTICAL REGULATIONS (LARs) OR EQUIVALENT

LAR 91: Sections 91.1015 and 91.1640 or equivalents

LAR 121: Section 121.995 (b) or equivalent

LAR 135: Section 135.565 (c) or equivalent

3. RELATED DOCUMENTS

Annex 6	Aircraft Operations
Annex 10	Aeronautical Telecommunications
	Volume I: Radio Navigation Aids
Doc 9613	Performance-based Navigation Manual (PBN)
Doc 9905	Required Navigation Performance Authorization Required (RNP AR) Procedure Design Manual (final draft)
Doc 8168	Aircraft Operations
	Volume I: Flight Procedures
	Volume II: Construction of Visual and Instrument Flight Procedures
AMC 20-26	Airworthiness Approval and Operational Criteria for RNP Authorization Required (RNP AR) Operations
FAA AC 90-101	Approval Guidance for RNP Procedures with SAAAR
IFFP/2 WP/5	Instrument flight procedure panel (IFPP) – PBN working group meeting - Working paper 5: Flight operational safety assessment (FOSA) prepared by Dave Nakamura.

4. DEFINITIONS AND ABBREVIATIONS

4.1 Definitions

a) **Area navigation (RNAV)**.- Navigation method that permits aircraft operations in any desired flight path within the coverage of ground-based or space-based navigation aids, or within the capability limits of autonomous aids, or through a combination of the two.

Area navigation includes performance-based navigation as well as other operations not contemplated in the performance-based navigation definition.

b) **Authorization required (AR).-** Specific authorization required by the CAA for an operator to be able to conduct RNP approach operations that need mandatory authorization (RNP AR APCH).

c) **Barometric vertical navigation (baro-VNAV).-** A function of some RNAV systems that displays an estimated vertical guide to the pilot, referred to as a specific vertical path. The estimated vertical guide is based on barometric altitude information and is commonly estimated as a geometric path between two waypoints or as an angle based on a single waypoint.

d) **Estimated position uncertainty (EPU)**.- A measure in nautical miles (NM) based on a defined scale that indicates the estimated performance of the current position of the aircraft, also known as navigation performance (ANP) or estimated position error (EPE) in some aircraft. The EPU is not an estimate of the actual error, but a defined statistical indication.

e) **Flight management system (FMS)**.- Integrated system made up by an on-board sensor, a receiver, and a computer with navigation and aircraft performance databases, capable of providing performance values and RNAV guidance to a display and automatic flight control system.

f) **Global positioning system (GPS)**.- The U.S. global navigation satellite system (GNSS) is a satellite based radio navigation system that uses precise distance measurements to determine the position, velocity and time anywhere in the world. The GPS is composed of space, control and user elements. The space element consists of at least 24 satellites in 6 orbiting planes. The control element consists of 5 monitoring stations, 3 ground antennas, and one main control station. The user element consists of antennas and receivers that provide the user with position, speed, and precise time information.

g) **Global navigation satellite system (GNSS)**.- Generic term used by ICAO to define any global positioning and timing system made up by one or more main satellite constellations, such as the GPS and the global navigation satellite system (GLONASS), aircraft receivers, and several integrity surveillance systems, including aircraft-based augmentation systems (ABAS), satellite-based augmentation systems (SBAS), such as the wide-area augmentation system (WAAS) and ground-based augmentation systems (GBAS), such as the local-area augmentation system (LAAS).

h) **Initial approach fix (IAF).-** Fix that marks the beginning of the initial segment and the end of the arrival segment, if applicable. In RNAV application, this fix is normally defined as a “fly-by fix”.

i) **Navigation specifications**.- A set of aircraft and flight crew requirements needed to support performance based navigation operations within a defined airspace. There are two kinds of navigation specifications:

Required navigation performance (RNP) specification.- A navigation specification based on area navigation that includes the requirement for on-board performance monitoring and alerting, designated by the prefix RNP, e.g., RNP 4, RNP APCH, RNP AR APCH.

Area navigation (RNAV) specification.- A navigation specification based on area navigation that does not include the requirement for on-board performance monitoring and alerting, designated by the prefix RNAV, e.g., RNAV 5, RNAV 2, RNAV 1.

Note 1.- The Performance-based Navigation (PBN) Manual (Doc 9613), Volume II, contains detailed guidance on navigation specifications.

Note 2.- The term RNP as previously defined as “a statement of the navigation performance, necessary for operation within a defined airspace”, has been removed from the Annexes to the Convention on International Civil Aviation as the concept of RNP has been overtaken by the concept of PBN. The term RNP in such Annexes is now solely used in contex of navigation specifications that require performance monitoring and alerting, e.g., RNP 4 refers to the aircraft and operating requirements, including a 4 NM lateral performance with on board performance monitoring and alerting that are detailed in the PBN Manual (Doc 9613).

j) **Performance-based navigation (PBN)**.- Performance-based area navigation requirements applicable to aircraft conducting operations on an ATS route, in an instrument approach procedure, or a designated airspace.

Performance requirements are expressed in the navigation specifications (RNAV and RNP specifications) in terms of the precision, integrity, continuity, availability, and functionality required for the intended operation within the context of a particular airspace concept.

k) **Primary field of view.-** For purposes of this AC, the primary field of view is within 15 degrees of the primary line of sight of the pilot.

l) **Radius to fix (RF) leg.-** An RF leg is defined as any circular path (an arc) with a constant radius around a defined turn centre that starts and ends in a fix.

m) **Receiver autonomous integrity monitoring (RAIM)**.- Technique used in a GPS receiver/processor to determine the integrity of its navigation signals, using only GPS signals or enhanced GPS signals with barometric altitude data. This determination is achieved by a consistency check between redundant pseudo-range measurements. At least one satellite in addition to those required must be available to obtain the navigation solution.

n) **RNP operations**.- Aircraft operations that use an RNP system for RNP applications.

o) **RNP system**.- Area navigation system that provides on-board performance control and alert.

p) **RNP value**.- The RNP value designates the lateral performance requirement associated with a procedure. Examples of RNP values are: RNP 0.3 and RNP 0.15.

q) **Way-point (WPT).-** A specified geographical location used to define an area navigation route or the flight path of an aircraft employing area navigation. Way-points are identified as either:

Fly-by way-point.- A way-point that requires turn anticipation to allow tangential interception of the next segment of a route or procedure.

Flyover way-point.- A way-point at which a turn is initiated in order to join the next segment of a route or procedure.

4.2 Abbreviations

a)	CAA	Civil aviation administration
b)	ABAS	Aircraft-based augmentation system
c)	AGL	Above ground level
d)	AP	Automatic pilot
e)	APCH	Approach
f)	APQ	Advance qualification program
g)	APV	Approach procedure with vertical guide
h)	AR	Authorization required
i)	AIP	Aeronautical information publication
j)	AIRAC	Aeronautical information regulation and control
k)	AC	Advisory circular (FAA)
l)	AFM	Aircraft flight manual
m)	AIM	Aeronautical information manual

n)	AMC	Acceptable means of compliance
o)	ANP	Navigation performance
p)	ANSP	Air navigation service provider
q)	ATC	Air traffic control
r)	ATS	Air traffic service
s)	baro-VNAV	Barometric vertical navigation
t)	AC	Advisory circular (SRVSOP)
u)	CDI	Course deviation indicator
v)	CDU	Control display unit
w)	CF	Course to a fix
x)	DA/H	Decision altitude/height
y)	DF	Direct to a fix
z)	DME	Distance-measuring equipment
aa)	EASA	European Aviation Safety Agency
bb)	EGPWS	Enhanced ground proximity warning system
cc)	EPE	Estimated position error
dd)	EPU	Estimated position uncertainty
ee)	EUROCAE	European Organization for Civil Aviation Equipage
ff)	FA	Course from a fix to an altitude
gg)	FAA	United States Federal Aviation Administration
hh)	FAF	Final approach fix
ii)	FD	Flight director
jj)	FMS	Flight management system
kk)	FOSA	Flight operational safety assessment
ll)	FSD	Maximum deflection
mm)	FTD	Flight training devices
nn)	FTE	Flight technical error
oo)	GBAS	Ground-based augmentation system
pp)	GNSS	Global navigation satellite system
qq)	GLONASS	Global navigation satellite system
rr)	GP	Glide path
ss)	GPS	Global positioning system
tt)	GS	Ground speed
uu)	HAL	Horizontal alert limit
vv)	HIL	Horizontal integrity limit
ww)	HPL	Horizontal protection level
xx)	IAC	Instrument approach chart

yy)	IAF	Initial approach fix
zz)	IFR	Instrument flight rules
aaa)	INS	Inertial navigation system
bbb)	ILS	Instrument landing system
ccc)	IRS	Inertial reference system
ddd)	IRU	Inertial reference unit
eee)	ISA	International standard atmosphere
fff)	LAAS	Local area augmentation system
ggg)	LAR	Latin American Aeronautical Regulations
hhh)	LNAV	Lateral navigation
iii)	LOA	Letter of authorization
jjj)	LOE	Line-oriented evaluation
kkk)	LOFT	Line-oriented flight training
lll)	MEL	Minimum equipment list
mmm)	NAVAIDS	Navigation aids
nnn)	NOTAM	Notice to airmen
ooo)	OACI	International Civil Aviation Organization
ppp)	OCA/H	Altitude/obstacle clearance altitude/height
qqq)	OEM	Original equipment manufacturer
rrr)	OM	Operations Manual
sss)	PANS-OPS	Procedurs for air navigation services – Aircraft operations
ttt)	PBN	Performance-based navigation
uuu)	PC	Proficiency check
vvv)	PDE	Path definition error
www)	PF	Pilot flying the aircraft
xxx)	POH	Pilot operations manual
yyy)	POI	Principal operations inspector
zzz)	PM	Pilot monitoring the aircraft
aaaa)	PT	Proficiency training
bbbb)	RA	Radio altimeter
cccc)	RAIM	Receiver autonomous integrity monitoring
dddd)	RF	Constant radius arc to a fix
eeee)	RF leg	Constant radius to fix arc leg
ffff)	RF turn	Constant radius to fix turn
gggg)	RNAV	Area navigation
hhhh)	RNP	Required navigation performance
iiii)	RNP APCH	Required navigation performance approach

jjjj)	RNP AR APCH	Required navigation performance authorization required approach
kkkk)	RTCA	Requirements and technical concepts for aviation
llll)	SBAS	Satellite-based augmentation system
mmmm)	SET	Selected event training
nnnn)	SPOT	Special-purpose operational training
oooo)	TF	Track to a fix
pppp)	TLS	Target level of safety
qqqq)	TOGA	Take-Off/Go-Around
rrrr)	VDI	Vertical deviation indicator
ssss)	VNAV	Vertical navigation
tttt)	VOR	VHF omnidirectional radio range
uuuu)	VPA	Vertical path angle
vvvv)	WAAS	Wide area augmentation system
wwww)	WPT	Waypoint

5. INTRODUCTION

5.1 ICAO Document 9613 - Manual on Required Navigation Performance (PBN), currently establishes two types of RNP navigation specifications for approach operations: RNP approach (RNP APCH) and RNP approach with authorization required (RNP AR APCH).

5.2 RNP AR APCH operations permit a high level of navigation performance and require that the operator meet additional aircraft and flight crew requirements in order to obtain an operational authorization from the CAA.

5.3 These operations can offer significant operational and safety advantages compared to other RNAV procedures, since they introduce additional navigation capabilities in terms of precision, integrity and functions allowing for operations with reduced obstacle clearance allowances that permit approach and departure procedures under circumstances in which other approach and departure procedures are neither possible nor satisfactory from the operational point of view.

5.4 RNP AR APCH operations include particular capabilities that require a special and mandatory authorization similar to that for ILS CAT II and CAT III operations.

5.5 All RNP AR APCH operations have reduced lateral obstacle evaluation areas and vertical obstacle clearance surfaces, based on aircraft and crew performance requirements stated in this AC.

5.6 RNP AR APCH operations are classified as vertical guide approach procedures (APV) according to Annex 6. In addition to lateral guide, this type of operation requires a positive vertical navigation guidance system for the final approach segment.

5.7 An RNP AR APCH procedure is designed when a direct approach is not operationally possible.

5.8 There are three features in procedure design criteria that must only be used when there is a specific operational need or a benefit. Accordingly, an operator may be authorized to any or all of the following sub-sets of these types of procedures:

- ✓ ability to fly a published arc, also referred to as a *radius to fix leg (RF leg)*
- ✓ *reduced obstacle evaluation area on the missed approach, also referred to as a missed approach requiring RNP less than 1.0*

- ✓ *an RNP AR APCH that employs a line of minima less than RNP 0.3 and/or a missed approach requiring an RNP less than 1.0*

5.9 An operator conducting an RNP AR APCH operation using a line of minima less than RNP 0.3 and/or a missed approach that requires an RNP less than 1.0 shall comply with paragraphs 5 and/or 6 of Appendix 2 to this AC.

5.10 The criteria in this AC are based on the use of multi-sensor navigation systems and barometric vertical navigation (baro-VNAV) systems.

5.11 The RNP AR APCH approches are use for operations with a final approach standard segment of RNP 0.3 o lower and are designed with straight and/or fixed radius (constant radius arc to a fix) segments.

5.12 According to ICAO Doc 9905 – Required navigation performance authorization required (RNP AR) procedure design manual, the maximum, standard and minimum RNP values, associated with the RNP AR APCH approaches segments are listed en Table 5-1:

Table 5-1 – RNP Values

Segment	**RNP values**		
	Maximum	**Standard**	**Minimum**
Arrival	2	2	1
Initial	1	1	0.1
Intermediate	1	1	0.3
Final	0.5	0.3	0.1
Missed approach	1	1	0.1*

* Used only with the provisions for minimum, straight final segment.

5.13 The standard RNP values described in Table 5-1 should be applied unless a lower value is required to achieve the required ground track or lowest OCA/H. The lowest RNP values are listed in the "Minimum" column of Table 5-1.

5.14 Procedures RNP AR APCH are named as $\text{RNAV}_{\text{(RNP)}}$. Through Aeronautical Information Publication (AIP) and aeronautical letters will be specified permitted sensors or required RNP value.

5.15 The procedures to be implemented pursuant to this AC will permit the use of high-quality lateral and vertical navigation capabilities to improve safety and reduce the risks of controlled flight into terrain (CFIT).

5.16 The material described in this AC has been developed based on the following documents:

- ✓ ICAO Doc 9613, Volume II, Part C, Chapter 6 – Implementing RNP AR APCH; and
- ✓ Working Paper IFPP/2 WP/5 – Flight operational safety assessment (FOSA) submitted to the ICAO PBN Working Group meeting (22 September to 3 October 2008).

5.17 Where possible, this AC has been harmonized with the following documents:

- ✓ EASA AMC 20-26 - Airworthiness approval and operational criteria for RNP authorization required (RNP AR) operations; and
- ✓ FAA AC 90-101 – Approval guidance for RNP procedures with SAAR.

Note.- *Notwithstanding harmonization efforts, operators shall note the differences between this AC and the aforementioned documents when requesting an authorization from the corresponding Administrations.*

6. GENERAL CONSIDERATIONS

6.1 Navaid infrastructure

a) RNP AR APCHs are only authorized based on GNSS as the primary navaid infrastructure. The use of DME/DME as a reversionary capability may be authorized for individual operators where the infrastructure supports the required performance. RNP AR APCH shall not be used in areas of known navigation signal (GNSS) interference.

Note.- *Most modern RNAV systems will prioritize inputs from GNSS and then DME/DME positioning.*

6.2 Communication and ATS surveillance

RNP AR APCHs do not require any unique communication or ATS surveillance considerations.

6.3 Obstacle clearance and route spacing

a) Guidance for the design of RNP AR approach procedures is provided in the ICAO Doc 9905 - Required Navigation Performance Authorization Required (RNP AR) Procedure Design Manual.

b) Terrain and obstacle data in the vicinity of the approach should be published in accordance with Annex 15 - Aeronautical Information Services.

c) Obstacle clearance must be ensured in accordance with the ICAO Required Navigation Performance Authorization Required (RNP AR) Procedure Design Manual (Doc 9905). A safety assessment must be conducted upon determining the route spacing.

6.4 Ground and flight validation

a) As RNP AR approaches do not have a specific underlying navigation facility, there is no requirement for flight inspection of navigation signals.

b) Due to the importance of publishing correct data, validation (ground and flight) of the procedure must be conducted in accordance with Doc 8168 – Procedures for air navigation services – Aircraft operations (PANS-OPS), Volume II, Part I, Section 2, Chapter 4, 4.6.

c) The validation process prior to publication should confirm obstacle data, basic flyability, track lengths, bank angles, descent gradients, runway alignment and compatibility with predictive terrain hazard warning functions (e.g. terrain awareness and warning systems) as well as the other factors listed in PANS-OPS.

d) When the State can verify, by ground validation, the accuracy and completeness of all obstacle data considered in the procedure design, and any other factors normally considered in the flight validation, then the flight validation requirement may be dispensed with regarding those particular factors.

e) Because of the unique nature of RNP AR approach procedures, simulator assessment of the procedure should be accomplished during the ground validation to evaluate the factors, including basic flyability, to be considered in the flight validation, to the extent possible, prior to the flight validation.

f) Due to variations in aircraft speeds, flight control system design, and navigation system design, the ground and flight validation does not confirm flyability for all of the various aircraft conducting RNP AR approach procedures. A thorough flyability assessment is therefore not required prior to publication, since flyability is individually assessed by the operator as part of their database updating and maintenance process.

6.5 Publication

a) The AIP should clearly indicate the navigation application is RNP AR APCH and that specific authorization is required. All routes must be based upon WGS-84 coordinates.

b) The navigation data published in the State AIP for the procedures and supporting navigation aids must meet the requirements of Chicago Convention Annex 14 and Anex 15 (as appropriate).

c) The original data defining the procedure should be available to the operators in a manner suitable to enable the operators to verify their navigation data. The navigation accuracy for all RNP AR APCH procedures should be clearly published in the AIP.

6.6 **Additional considerations**

a) Current local pressure settings must be provided to support RNP AR APCHs, when the aircraft's achieved vertical path is dependent on that setting. Failure to report a correct setting can lead to the aircraft leaving the obstacle clearance area.

b) The criteria in this navigation specification must meet the safety assessment criteria listed in Appendix 9. As a result, the safety assessment for each procedure need only focus on areas of unique operational risk.

7. DESCRIPTION OF THE NAVIGATION SYSTEM

7.1 Lateral navigation (LNAV)

a) In LNAV, RNP equipment enables the aircraft to navigate in accordance with appropriate routing instructions along a path defined by waypoints maintained in an on-board navigation database.

Note.- *Normally, LNAV is a mode of flight guidance systems where the RNP equipment provides path steering commands to the flight guidance system that controls flight technical error (FTE) through either manual pilot control with a path deviation display or through FD or AP coupling.*

b) For purposes of this AC, RNP AR APCH operations are based on the use of RNP equipment that automatically determines aircraft position on the horizontal plane using data inputs from the following types of position sensors (listed in no specific order of priority or combination), but whose primary basis for positioning is the GNSS.

1) Global navigation satellite system (GNSS).

2) Inertial navigation system (INS) or inertial reference system (IRS), with automatic position updating from suitable radio-based navigation equipment.

3) Distance measuring equipment (DME) that provides measurements from two or more ground stations (DME/DME)

Note.- *Depending on DME infrastructure, an operator may use DME/DME position updating as a means of reversal. This function must be assessed on a case-by-case basis for each procedure and approved at the operational level.*

7.2 Vertical navigation (VNAV)

a) In VNAV, the system enables the aircraft to fly level and descend relative to a linear, point-to-point vertical path that is maintained in an on-board navigation database. The vertical profile will be based on altitude constraints or vertical path angles (VPA) where appropriate, associated with the vertical navigation path waypoints.

Note.- *Normally, VNAV is a mode of flight guidance systems, where RNP equipment with VNAV capability provides path steering commands to the flight guidance system that controls the flight technical error (FTE) through either manual pilot control with vertical deviation display or through FD or AP coupling.*

8. AIRCRAFT EQUIPMENT REQUIREMENTS

8.1 The operator must establish and have a configuration list available describing in detail the components and equipment to be used for RNP AR APCH operations.

8.2 The required equipment list shall be established during the operational approval process, taking into account the AFM and available operational mitigation methods. This list shall be used to update the MEL of each type of aircraft for which the operator submits an operational application.

8.3 The details of the equipment and its use in accordance with the characteristic(s) of each approach are described in the appendices to this AC.

9. AIRWORTHINESS AND OPERATIONAL APPROVAL

9.1 In order to get an RNP AR APCH authorization, a commercial air transport operator shall obtain two types of approval:

a) an airworthiness approval from the State of Registry; (see Article 31 of the Chicago Convention and paragraphs 5.2.3 and 8.1.1 of Annex 6, Part I); and

b) an operational approval from the State of the Operator (see paragraph 4.2.1 and Attachment F to Annex 6, Part I).

9.2 For general aviation operators, the State of Registry (See paragraph 2.5.2.2 of Annex 6 Part II) will determine if the aircraft meets the applicable RNP AR APCH requirements and will issue the operational authorization (*e.g.,* a letter of authorization – LOA).

9.3 An operator that has obtained operational approval can conduct RNP AR APCH operations in the same way as an operator that has been authorized to conduct ILS CAT II and III operations.

9.4 Before submitting the application, manufacturers and operators shall review all the performance requirements. Compliance with airworthiness requirements or the installation of the equipment, by itself, does not constitute operational approval.

9.5 Appendix 1 to this AC contains the RNP AR APCH procedure characteristics that must be taken into account by operators when conducting this type of operations.

9.6 In order to get operational approval, operators shall meet the requirements contained in Appendices 2 to 6 to this AC.

9.7 Appendix 7 contains a summarized list of requirements to obtain RNP AR APCH authorization, including the documents to be included in the application.

9.8 Appendix 8 contains a summarized guide on the approval process to get an RNP AR APCH authorization.

9.9 Appendix 9 provides guidance on the flight operational safety assessment (FOSA).

10. AIRWORTHINESS APPROVAL

10.1 Aircraft qualification documentation

a) Manufactures should develop aircraft qualification documentation showing compliance with Appendix 2 of this AC. This documentation shall identify the optional capabilities (*e.g.,* RF legs and RNP missed approaches), the RNP capability of each aircraft configuration, and the characteristics that may alleviate the need for operational mitigation. This documentation shall also define the recommended RNP maintenance procedures.

10.2 Aircraft acceptability

a) *For new aircraft*.- the aircraft qualification documentation can be approved by the CAA as part of an aircraft certification project, and will be reflected in the AFM and related documents.

b) *For aircraft in service*.- The operator shall submit the aircraft qualification documentation produced by the manufacturers to the corresponding CAA bodies (*e.g.*, aircraft certification division, or airworthiness inspection division, or equivalents). These bodies shall accept, as appropriate, the data package for RNP AR APCH operations. This acceptance will be documented in a letter addressed to the operator.

10.3 Aircraft modification

a) If any aircraft system required for RNP AR APCH operations is instaled or modified (e.g., software or hadware change), the aircraft installation or modification must be approved.

b) The operator must obtain a new operational approval supported by the manufacturer´s updated aircraft qualification and operational documentation.

10.4 Continued airworhiness

a) The operators of aircraft approved to perform RNR AR APCH operations, must ensure the continuity of the technical capacity of them, in order to meet technical requirements established in this AC.

b) Each operator who applies for RNP AR APCH operational approval shall submit to the CAA of State of registry, a maintenance and inspection program that includes all those requirements of maintenance necessary to ensure that navigation systems continue fulfilling the RNP AR APCH approval criteria.

c) The following maintenance documents must be revised, as appropriate, to incorporate RNP AR APCH aspects:

1) Maintenance control manual (MCM);

2) Illustrated parts catalogs (IPC); and

3) Maintenance program.

d) The approved maintenance program for the affected aircrafts should include maintenance practices listed in maintenance manuals of the aircraft manufacturer and its components, and must consider:

1) that equipment involved in the RNP AR APCH operation should be maintained according to directions given by manufacturer's components;

2) that any amendment or change of navigation system affecting in any way RNP AR APCH initial approval, must be forwarded and reviewed by the CAA for its acceptance or approval of such changes prior to its implementation; and

3) that any repair that is not included in the approved/accepted maintenance documentation, and that could affect the integrity of navigation performance, should be forwarded to the CAA for acceptance or approval thereof.

e) Within the RNP AR APCH maintenance documentation should be presented the training program of maintenance personnel, which inter alia, should include:

1) PBN concept;

2) RNP AR APCH application;

3) equipment involved in a RNP AR APCH operation; and

4) MEL use.

11. OPERATIONAL APPROVAL

11.1 In order to obtain RNP AR APCH authorization, the operator must meet the criteria set forth in this paragraph and in Appendix 7 - Requirements to obtain RNP AR APCH authorization.

11.2 **RNP AR APCH Operational documentation**

a) The operator will submit operational documentation for RNP AR APCH operations in accordance with the following appendices to this AC: Appendix 3 – Navigation data validation program; Appendix 4 – Operational considerations; Appendix 5 – Training programs; and Appendix 6 – RNP monitoring programs.

b) *For new aircraft*.- The RNP AR APCH operational documentation submitted by the operator will be accepted by the relevant CAA body (for example, the aircraft certification division or flight standard body or equivalent).

c) *For aircraft in service*.- The operator shall send the RNP AR APCH operational documentation to the corresponding CAA bodies (for example, the aircraft certification division or flight standard body or equivalent). These entities will accept, as appropriate, the RNP AR APCH operational documentation. This acceptance will be documented in a letter addressed to the aircraft operator.

11.3 Operator approval

a) LAR 91, 121, and 135 operators shall submit to the flight standard body or equivalent evidence of compliance with the aircraft operational or qualification documentation accepted by the CAA as described in Annex 7 to this AC. This documentation will indicate compliance with Appendices 2 to 9 and will be specific to aircraft equipment and procedures. Once the operator has met the requirements of this AC or equivalent, the CAA will issue the operational specifications (OpSpecs) for LAR 121 or 135 operators or a letter of authorization (LOA) for LAR 91 operators, authorizing RNP AR APCH operations.

b) **Provisional authorization**

1) The operator will be authorized to conduct RNP AR APCH operations using RNP 0.3 minima during the first 90 days of operation or the period stipulated by the CAA, and at least during the first 100 approaches in each type of aircraft.

2) For approaches without a line of minima associated with RNP 0.3 (minima under 0.3), the procedure shall be conducted under visual meteorological conditions (VMC).

3) The provisional authorization will be withdrawn once the operator has completed the applicable period of time and the required number of approaches and once the CAA has reviewed the RNP AR APCH monitoring program reports.

Note 1.- *Operators with experience in equivalent RNP AR APCH operations may receive credit to reduce provisional authorization requirements.*

Note 2.*- Operators with experience in RNP AR APCH operations that are applying for new or modified system or aircraft operations, variations of the aircraft type or different aircraft types with identical crew procedures and interface may use reduced periods or approaches in the provisional authorization (for example, periods of less than 90 days and approaches of less than 50), as determined by the CAA.*

Note 3.*- In particular circumstances in which compliance with 50 successful approaches could take a long time due to factors such as the small number of aircraft in the fleet, limited opportunities to use aerodromes with the appropriate procedures, and when an equivalent level of reliability can be obtained, consideration can be given, on a case-by-case basis, to a reduction in the required number of approaches.*

c) **Final authorization**

1) The CAA will issue the OpSpecs or the LOA authorizing the use of the lowest applicable minima once the operators have successfully completed the time period and the number of approaches required by the CAA, as established in paragraph b) above.

APPENDIX 1

RNP AR APCH INSTRUMENT APPROACH PROCEDURES

1. INTRODUCTION

a) ICAO Doc 9905 – *Required navigation performance authorization required (RNP AR) procedure design manual*, provides RNP AR APCH procedure design criteria.

b) This appendix provides a summary of the key characteristics of approach procedures, and introduces the types of RNP approach operations.

2. PARTICULAR CHARACTERISTICS OF RNP AR APCH APPROACHES

a) **RNP value**.- Each line of minima published has an associated RNP value; for example, RNP 0.3 or RNP 0.15. A minimum RNP value is documented as part of an RNP AR APCH authorization for each operator, and it may vary depending on aircraft configuration or operational procedures (for example, inoperative GPS, use of FD with or without AP).

b) **Procedures that include *radius to fix legs* (RF legs)**.- Some RNP procedures have curved paths, known as *radius to fix legs (RF legs).* Since not all aircraft can fly this type of legs, pilots are responsible for knowing if they can conduct an RNP AR APCH procedure with an RF leg. RNP requirements for RF legs will be indicated in the note section of instrument approach charts (IAC) or in the applicable initial approach fix (IAF).

c) **Missed approaches that require RNP values of less than 1.0**.- In designated locations, the airspace or the obstacle area will require an RNP capability of less than 1.0 during a missed approach from any location in the procedure. Navigation system reliability must be very high in these locations. These approaches will normally require redundant equipment since no single point-of-failure can cause a loss of RNP capability.

d) **Non-standard speeds or climb gradients**.- RNP AR APCH procedures are developed on the basis of standard approach speeds and a with climb gradient of 200 ft/NM in the missed approach. Any exception to these standards will be stated in the approach procedure and the operator will ensure compliance with any published limitation before conducting the operation.

e) **Temperature limits**.-

1) High and low temperature limits are identified in RNP AR APCH procedures for aircraft using barometric vertical navigation (baro-VNAV) without temperature compensation on the approach.

2) Aircraft using baro-VNAV with temperature compensation, or an alternate means of vertical guidance (*e.g.,* SBAS) can ignore temperature restrictions.

3) Since temperature limits established in the charts are assessed only for obstacle clearance in the final approach segment, and taking into account that temperature compensation affects only vertical guidance, the pilot may need to adjust the minimum altitude in the initial and intermediate approach segments and in the decision altitude/height (DA/H)).

Note 1.- *Temperature affects the indicated altitude. The effect is similar to having high and low pressure changes, but not as significant as those changes. When the temperature is higher than the standard (ISA), the aircraft will be flying above the indicated altitude. When the temperature is lower than the standard, the aircraft will be flying below the altitude indicated in the altimeter. For further information, refer to altimeter errors in the aeronautical information manual (AIM).*

Note 2.- *Pilots are responsible for all low (cold) temperature corrections required at all minimum altitudes/heights published. This includes:*

- the altitudes/heights for the initial and intermediate segments;
- the DA/H; and
- the subsequent missed approach altitudes/heights.

Note 2.- *The final approach path VPA is protected against the effects of low temperatures by the procedure design.*

f) **Aircraft size**.- The minima to be obtained may depend on the size of the aircraft. Large aircraft may require higher minima due to the height of the landing gear and/or aircraft wingspan. When appropriate, aircraft size restrictions will be reflected in RNP AR APCH procedure charts.

APPENDIX 2

AIRCRAFT QUALIFICATION

1. INTRODUCTION

a) This appendix describes aircraft performance and the functional criteria for qualifying an aircraft for RNP AR APCH operations.

b) Applicants may establish compliance with this appendix based on the type certification or supplementary type certification, and document said compliance in the AFM (supplement).

c) The operator of a previously certified aircraft may document compliance with this aircraft certification criterion without a new airworthiness project (for example, without a change in the AFM) and must report to the aircraft certification division or equivalent any new performance not covered by the original airworthiness approval.

d) The AFM or other proof of aircraft qualification shall indicate the normal and non-normal flight crew procedures, responses to failure alerts, and any other limitation, including information on the operation modes required for flying an RNP AR APCH procedure.

e) In addition to the specific RNP AR APCH guide presented in this AC, the aircraft must comply with AC 20-129 – Airworthiness approval of vertical navigation (VNAV) systems for use in the U.S. National Airspace System (NAS) and Alaska and either with AC 20-130 () – Airworthiness approval of navigation or flight management systems integrating multiple navigation sensors or AC 20-138 () – Airworthiness approval of NAVSTAR Global Positioning System (GPS) for use as a VFR and IFR supplemental navigation system, or equivalent documents.

2. PERFORMANCE REQUIREMENTS

This paragraph defines the general performance requirements for aircraft qualification. Paragraphs 3, 4, and 5 of this appendix provide guidance material on acceptable methods of compliance to meet such requirements.

a) **Path definition.-** Aircraft performance is assessed around the path defined by the published procedure and by Section 3.2 of document RTCA/DO.236B. All flight paths used in conjunction with the final approach segment will be defined by the flight path angle (VPA) (RTCA/DO-236B, Section 3.2.8.4.3) as a straight line to a fix and altitude.

b) **Lateral precision.-** Any aircraft conducting RNP AR APCH procedures must have a cross-track navigation error not greater than the precision value (0.1 NM to 0.3 NM) applicable to 95% of the flight time. This error includes the position error, the flight technical error (PTE), and the display system error. Likewise, the along-path position error must not be greater than the precision value applicable to 95 % of the flight time.

c) **Vertical precision.-** The vertical system error includes the altimeter error (assuming international standard atmosphere (ISA) temperature and lapse rates), the along-path effect of the error, the system calculation error, and the flight technical error. 99.7% of the system error in the vertical direction must not be less than (in feet):

$$\sqrt{\left((6076.115)(1.225)\mathbf{RNP}\cdot \tan\theta\right)^2 + \left(60\tan\theta\right)^2 + 75^2 + \left(\left(-8.8\cdot 10^{-8}\right)(\mathbf{h}+\Delta\mathbf{h})^2 + \left(6.5\cdot 10^{-3}\right)(\mathbf{h}+\Delta\mathbf{h}) + 50\right)^2}$$

Where θ is the vertical navigation path angle, h is the height of the local altimeter reporting station, and Δh is the height of the aircraft over the reporting station.

d) **Airspace containment.-** RNP AR APCH approaches are published as performance-based approaches; therefore, they do not require any specific procedure or technology, but rather a performance level.

1) **RNP and baro-VNAV aircraft.-** This AC provides acceptable methods of compliance for aircraft using an RNP system based mainly on GNSS, and a vertical navigation system (VNAV) based on a barometric altimeter. Paragraphs 3, 4, and 5 of this appendix, together with the guide established in Appendices 3 and 4, describe an acceptable method of acceptance to obtain the required navigation performance. Aircraft and procedures that comply with these paragraphs and appendices meet the airspace containment requirement.

2) **Other alternate systems or methods of compliance.-** For other alternate systems or methods of compliance, the likelihood of the aircraft exceeding the lateral and vertical limits of the obstacle clearance volume must not exceed 10^{-7} per approach (Doc 9905 - *Manual for the design of navigation required performance procedures with authorization required (RNP AR)*, including approach and missed approach. This requirement can be met through a safety assessment, applying:

✓ appropriate quantitative numerical methods;

✓ operational and procedural qualitative considerations and mitigations; or

✓ an appropriate combination of both quantitative and qualitative methods.

Note 1.- *This requirement applies to the total likelihood of excursions outside of the obstacle clearance volume, including events caused by latent conditions (integrity) and detected conditions (continuity) if the aircraft does not remain within the obstacle clearance volume after the failure is announced. The alert control limit, the latent status of the alert, the crew response time, and the aircraft response shall be taken into account when ensuring that the aircraft will not go outside the obstacle clearance volume. The requirement applies to a single procedure, considering the exposure time of the operation, the radio aid (NAVAID) geometry, and the navigation performance available for each published approach.*

Note 2.*- This containment requirement is derived from the operational requirement and is particularly different from the requirement specified in Document RTCA/DO-236B. The requirement in Document RTCA/DO-236B was developed to expedite airspace design and is not directly equivalent to obstacle clearance.*

e) **System control.-** A critical component of RNP during approach is the capability of the aircraft navigation system to control the navigation performance obtained and identify for the flight crew whether or not the operational requirement is being met during the operation.

3. GENERAL RNP AR APCH REQUIREMENTS

a) **Navigation sensors.-** This section identifies the particular features of navigation sensors within the context of RNP AR APCH operations.

1) **Global positioning system (GPS).-**

(a) The sensor must meet the criteria of FAA AC 20-138 (). For systems that comply with this AC, the following sensor precisions can be used in the total system precision analysis without any additional justification:

(1) GPS sensor precision better than 36 m (95%); and

(2) augmented GPS (GBAS or SBAS) sensor precision better than 2 m (95%).

(b) In case of latent failure of the GPS satellite and marginal geometry of said satellite (*e.g.,* horizontal integrity limit (HIL) equal to the horizontal alert limit (HAL)), the likelihood of the aircraft remaining within the obstacle clearance volume used to assess the procedure must be greater than 95% (both laterally and vertically).

Note.- *GNSS-based sensors produce an HIL, also known as horizontal protection level (HPL) (see AC 20-138A, Appendix 1 and document RTCA/DO-229C for an explanation of these terms). The HIL is a measure of the estimated position error, assuming a latent failure is present. Instead of a detailed analysis of the effects of latent failures on the total system error, an acceptable means of compliance for GNSS-based systems is to ensure the HIL remains twice as low as the navigation precision, minus 95% of the flight technical error (FTE), during RNP AR APCH operations.*

2) **Inertial reference system (IRS).-** An IRS must meet the criteria of LAR 121 Appendix G or

US 14 CFR Part 121 Appendix G or equivalent. While Appendix G defines the 2-NM-per-hour drift rate (95%) requirement for flights up to 10 hours, this rate may not apply to an RNP system after loss of position updating. It is assumed that systems that have demonstrated compliance with LAR 121 Appendix G have an initial drift rate of 8 NM/hour for the first 30 minutes (95%), without further substantiation. Aircraft manufacturers and applicants can demonstrate improved inertial performance in accordance with the methods described in Appendix 1 or 2 of FAA Order 8400.12A.

Note.- *Integrated GPS/INS position solutions reduce the rate of degradation after loss of position updating. For coupled GPS/IRUs, RTCA/DO-229C Appendix R provides additional guidance.*

3) **Distance measuring equipment (DME).-** Initiation of all RNP AR APCH procedures is based on GNSS updating. Except where the use of DME in a procedure is specifically designated as “not authorized”, DME/DME updating can be used as a reversal mode during the approach and missed approach when the system complies with the navigation precision. The manufacturer and the operator shall identify any DME infrastructure or procedure limitation preventing an aircraft type from meeting this requirement.

4) **VHF omnidirectional radio range (VOR).-** For initial RNP AR APCH implementation, the RNP system may not use VOR updating. The manufacturer and the operator shall identify any constraints on the VOR infrastructure or the procedure for a given aircraft to comply with this requirement.

Note.- *This requirement does not prohibit the capability of the VOR equipment, provided there is a direct means to inhibit its update. A procedure that allows the flight crew to inhibit VOR updating or to execute a missed approach if the system reverts to VOR updating may meet this requirement.*

5) **Multi-sensor systems**.- For multi-sensor systems, there must be automatic reversal to an alternate RNAV sensor if the primary RNAV sensor fails. Automatic reversal from one multi-sensor system to another multi-sensor system is not required.

6) **Altimetry system error**.- 99.7% of the altimetry system error for each aircraft (assuming international standard atmosphere temperature and lapse rate) must be less or equal to the following, with the aircraft in the approach configuration:

$$\mathbf{ASE} = -8.8 \cdot 10^{-8} \cdot \mathbf{H}^2 + 6.5 \cdot 10^{-3} \cdot \mathbf{H} + 50$$

Where H is the true altitude of the aircraft

7) **Temperature compensation systems.-** Systems that provide temperature-based corrections to the barometric VNAV guidance must comply with RTCA/DO-236 Appendix H.2. This applies to the final approach segment. Compliance with this requirement shall be documented to enable the operator to conduct RNP AR APCH approaches when the actual temperature is above or below the published procedure design limit. Appendix H.2 also provides guidance on operational aspects related to temperature compensation systems, such as intercepting compensated paths from non-compensated procedure altitudes.

b) **Flight path definition and flight planning**

1) **Track-keeping and transition legs.-** The aircraft must be capable of executing transition legs and maintain tracks consistent with the following paths:

(a) a geodetic line between two fixes;

(b) a direct to fix path;

(c) a specific track to a fix, defined by a course; and

(d) a specific track to an altitude.

Note 1.- *The standards for these paths may be found in documents EUROCAE ED-75 / RTCA DO-236B and in ARINC Specification 424 – Navigation database. These standards refer to these paths as path terminators: Track to a fix (TF), Direct to a fix (DF), Course to a fix (CF), Course from a fix to an altitude (FA). Likewise, some procedures* *require radius to a fix (RF) legs as described in paragraph 4 of this appendix. Documents EUROCAE ED-75A/RTCA DO-236B and ED-77/DO-201A describe in more detail the application of these paths.*

***Note 2.**- Navigation systems can accommodate other ARINC 424 path terminators (e.g., heading to a manual terminator (VM)). Missed approach procedures may use these types of paths when there is no requirement for RNP containment.*

2) **Fly-By and flyover fixes**.- The aircraft navigation system must be capable of executing fly-by and flyover fixes. For fly-by turns, the navigation system must limit the path definition within the theoretical transition area defined in document EUROCAE ED-75B/RTCA DO-236B under the wind conditions identified in ICAO Doc 9905. The flyover turn is not compatible with RNP flight tracks and will only be used when there is no repetitive path requirement.

3) **Waypoint resolution error**.- The navigation database must provide sufficient data resolution to ensure the navigation system achieves the required precision. A waypoint resolution error must be less than or equal to 60 ft, including both the data storage resolution and the RNP system computational resolution used internally for construction of flight plan waypoints. The navigation database must contain vertical angles (flight path angles) stored to a resolution of hundredths of a degree, with a computational resolution such that the system-defined path is within 5 ft of the published path.

4) **"Direct to" function capability -** The navigation system must have a "direct to" function that the flight crew can activate at any time. This function must be available for any fix. The navigation system must also be capable of generating a geodetic path "to" the designated fix, without turns and undue delays.

5) **Ability to define a vertical path**.- The navigation system must be capable of defining a vertical path for a flight path angle to a fix. The navigation system must also be capable of specifying a vertical path between the altitude constraints of two fixes in the flight plan. Fix altitude constraints must be defined as one of the following:

(a) an AT or ABOVE altitude constraint (for example, 2400A) may be appropriate for situations where it is not necessary to limit the vertical path;

(b) an AT or BELOW altitude constraint (for example, 4800B) may be appropriate for situations where it is not necessary to limit the vertical path;

(c) an AT altitude constraint (for example, 5200); or

(d) a WINDOW-type altitude constraint (for example, 2400A3400B).

***Note.-** For RNP AR APCH procedures, any segment with a published vertical path will define that path based on an angle to the fix and altitude.*

6) **Altitudes and/or speeds.-** Altitudes and speeds associated with published procedures must be extracted from the navigation database.

7) **Path construction.**- The system must be capable of constructing a path to provide guidance from current position to a constrained fix.

8) **Ability to load procedures from the navigation database.-** The navigation system must be capable of loading the entire procedure(s) to be flown into the RNP system from an on-board database. This includes the approach (including a vertical angle), the missed approach, and the approach transitions for the selected aerodrome and runway.

9) **Means to retrieve and display navigation data.-** The navigation system must provide the flight crew the ability to verify the procedures to be flown through a review of the data stored in the on-board navigation database. This includes the ability to review the data for individual waypoints and navigation aids.

10) **Magnetic variation.**- For paths defined by a course (path terminators: Course to a fix (CF) and Course from a fix to an altitude (FA)), the navigation system must use the magnetic variation value for the procedure loaded on the navigation database.

11) **Changes in the RNP value.**- Changes to lower RNP values must be completed at the fix that

defines the leg with the lowest RNP value. Any operational procedure necessary to accomplish this must be identified.

12) **Automatic leg sequencing.**- The navigation system must provide the ability to automatically sequence to the next leg and display the sequencing to the flight crew in a readily visible manner.

13) **Display of altitude restrictions.**- A display of altitude restrictions associated to flight plan fixes must be available to the pilot. If there is a particular procedure in the navigation database with a flight path angle associated with any flight plan leg, the equipment must display the flight path angle for that leg.

c) **Demonstration of path steering performance.**- When the RNP demonstration includes a path steering performance demonstration (flight technical error), the applicant must complete such demonstration in accordance with paragraphs 5.19.2.2 and 5.19.3.1 of FAA AC 120-29A.

d) **Displays.-**

1) **Continuous display of deviation.-** The navigation system must provide the ability to continuously display the aircraft position relative to the defined RNP path (both lateral and vertical deviation) to the pilot flying the aircraft, on the primary flight navigation instruments. The display must allow the pilot to readily distinguish if the cross-track deviation exceeds the navigation precision (or a smaller value) or if the vertical deviation exceeds 75 ft (or a smaller value).

(a) It is advisable that a appropriately-scaled non-numeric deviation display (*e.g.,* the lateral deviation indicator or the vertical deviation indicator) be located in the primary field of view of the pilot. A course deviation indicator (CDI) is acceptable provided it demonstrates an appropriate scaling and sensitivity for the intended navigation precision and operation. With a scalable CDI, the scale should be derived from the RNP selection, and does not require a separate selection of the CDI scale. Alerting and annunciation limits must also match the scaling values. If the equipment uses a pre-established navigation precision to describe the operational mode (*e.g.,* en route, terminal area, and approach), then displaying the operational mode is an acceptable means from which the flight crew can derive the CDI scale sensitivity.

(b) Normally, a numeric deviation display or the display of a graph on a map without a properly regulated deviation indicator is not acceptable. The use of a numeric display or a map display may be possible depending on the flight crew workload, display characteristics, flight crew procedures and training. Furthermore, initial and recurrent training or on-line experience must be provided to the flight crew, but this solution increases flight crew workload during approach, and imposes additional costs to the operator due to training requirements.

2) **Identification of the active (to) waypoint.-** The navigation system must provide a display identifying the active waypoint, either in the primary field of view of the pilot or on a display that is visible to, and of ready access by the flight crew.

3) **Display of distance and heading.-** The navigation system must provide a display of distance and heading to the active (to) waypoint in the primary field of view of the pilot. Where not viable, an easily accessible page on the control display unit (CDU), readily visible to the flight crew, may display the information.

4) **Display of groundspeed (GS) and time.-** The navigation system must provide a display of groundspeed and time to the active (to) waypoint in the primary field of view of the pilot. Where not viable, an easily accessible page on the control display unit, readily visible to the flight crew, may display the information.

5) **Display of to/from the active fix.-** The navigation system must provide a to/from display in the primary field of view of the pilot.

6) **Desired track display.-** The navigation system must be capable of continuously displaying

the desired RNP track to the pilot flying the aircraft. The display must be on the primary flight instruments for aircraft navigation.

7) **Display of aircraft track.**- The navigation system must provide a display of the actual aircraft track (or track angle error), either in the primary field of view of the pilot, or on a display that is visible to, and readily accessible by the flight crew.

8) **Failure annunciation.-** The aircraft must provide a means to annunciate failures of any component of the RNP system, including navigation sensors. The annunciation must be visible to the pilot and located in the primary field of view of the pilot.

9) **Enslaved course selector.-** The navigation system must provide a course selector automatically enslaved to the computed RNP path.

10) **RNP path display.-** When the minimum flight crew is two pilots, the navigation system must provide a readily visible means for the pilot monitoring the aircraft to verify the defined RNP path and the aircraft position relative to said path.

11) **Display of distance to go.-** The navigation system must provide the ability to display distance to go to any waypoint selected by the flight crew.

12) **Display of distance between flight plan waypoints.**- The navigation system must provide the ability to display the distance between flight plan waypoints.

13) **Display of deviation.** The navigation system must provide a numeric display of vertical deviation with a resolution of 10 ft or less, and a lateral deviation with a resolution of 0.01 NM or less.

14) **Display of barometric altitude.**- The aircraft must display barometric altitude from two independent sources, one in the primary field of view of each pilot.

Note.- *This display supports an operational cross-check of altitude sources. If the aircraft altitude sources are automatically compared, the output of the independent altimetry sources, including independent aircraft static air pressure systems, must be analyzed to ensure that they can provide an alert in the primary field of view of the pilot when deviations exceed 75 ft. Such comparator monitor function shall be documented so that it may eliminate the need for an operational mitigation.*

15) **Display of active sensors.-** The aircraft must display the navigation sensor(s) in use. It is recommended that this display be provided in the primary field of view of the pilot.

Note.- *This display is used to support operational contingency procedures. If such display is not provided in the primary field of view of the pilot, flight crew procedures can mitigate the need for this display if the workload is designated as acceptable.*

e) **Design assurance**.- The system design assurance must be consistent with at least a major failure condition with respect to false lateral or vertical guidance during an RNP AR APCH.

Note.- *The false vertical or lateral RNP guidance display is considered to be a (severe or major) hazardous failure condition for RNP AR APCH with an RNP value of less than 0.3. Systems designated as consistent with this effect should be documented since they can eliminate the need for some aircraft operational mitigation.*

f) **Navigation database**

1) **Navigation database.-** The aircraft navigation system must use a navigation database that:

(a) can receive updates in accordance with the AIRAC cycle; and

(b) permits the retrieval and loading of RNP AR APCH procedures from and into the RNP system.

2) **Database protection.-** The on-board navigation database must be protected against flight crew modification of stored data.

Note.- *When a procedure is loaded into the database, the RNP system must fly the published procedure. This does not prevent the flight crew from having the means to modify a procedure or route that has been loaded into the RNP system. However, the procedures stored in the navigation database must not be modified and must remain intact in the navigation database for reference and future use.*

3) **Validity period display.-** The aircraft must provide a means to display the validity period of the on-board navigation database to the flight crew.

4. REQUIREMENTS FOR RNP AR APCH PROCEDURES WITH RF LEGS

This section defines the additional requirements for executing approaches with RF legs. The AFM or the aircraft qualification guidance shall state whether or not this capability is provided.

a) The navigation system must be capable of executing transition legs and maintaining tracks that are consistent with the RF legs between two fixes.

b) The aircraft must have an electronic map displaying the procedure selected.

c) The FMC, the flight management system, and the autopilot must be capable of commanding a bank angle of 25º above 400 ft AGL and up to 8º below 400 ft AGL.

d) Once a missed approach or go-around (through the activation of TOGA of other means) has been initiated, the flight guidance mode must remain in LNAV to enable continuous track guidance during an RF leg.

5. REQUIREMENTS FOR APPROACHES WITH AN RNP OF LESS THAN 0.3

The AFM or aircraft qualification guidance must state whether or not the ability of executing approaches with an RNP of less than 0.3 is provided for each aircraft configuration (*e.g.,* two APs may achieve an RNP capability that is lower to that achieved with two flight directors).

a) **Single point of failure.-** No single point of failure can cause the loss of guidance compatible with the RNP value of the approach. Typically, the aircraft must have at least the following equipment:

   1) two GNSS sensors;

   2) two FMS;

   3) two air information systems;

   4) two AP; and

   5) one inertial reference unit (IRU).

b) **Design assurance.-** The system design assurance must be consistent with at least a severe or major failure condition due to loss of lateral or vertical guidance during an RNP AR APCH where an RNP value of less than 0.3 is required to avoid obstacles and terrain while executing an approach.

   Note.- *The loss of lateral guidance display during RNP AR APCH operations that require an RNP value of less than 0.3 to avoid obstacles or terrain is considered as a hazardous (severe or major) failure condition. The AFM shall document designated systems that are consistent with this effect. This documentation shall describe the specific configuration of the aircraft or the mode of operation to obtain RNP values of less than 0.3. Compliance with this requirement may replace the general requirement for the two pieces of equipment described above.*

c) **Go-around guidance**.- Once a missed approach or go-around maneuver has been initiated (through activation of TOGA or other means), the flight guidance mode must remain in LNAV to enable continuous track guidance during an RF leg. If the aircraft does not provide this capability, the following requirements apply:

   1) If the aircraft provides RF leg capability, the lateral path after initiating a go-around maneuver (TOGA) (taking into account a straight segment of at least 50 seconds between the point where the RF leg ends and the decision altitude (DA)) must fall within 1º of the track defined by the straight segment through the DA point. The previous turn may have an arbitrary angular extension and a turn radius as small as 1 NM, with speeds consistent with the approach conditions and the turn radius.

   2) The flight crew must be capable of coupling the AP or DF to the RNP system (connect LNAV) at 400 ft AGL.

d) **Loss of GNSS.-** After initiating a go-around or missed approach following loss of GNSS, the aircraft must automatically revert to another means of navigation that complies with the RNP value.

6. REQUIREMENTS FOR MISSED APPROACHES WITH RNP LESS THAN 1.0

The AFM or the aircraft qualification guidance shall identify if the aircraft can achieve an RNP value of less than 1.0 in a missed approach. The AFM or the aircraft qualification guidance shall also specify the aircraft configuration or operating mode required to obtain RNP values of less than 1.0 (*e.g.,* two APs may achieve an RNP capability that is lower than that achieved with two FDs).

a) **Single point of failure**.- No single point of failure can cause the loss of guidance compliant with an RNP value associated to a missed approach procedure. Typically, the aircraft must have at least the following equipment:

1) two GNSS sensors;

2) dual FMS;

3) two air information systems;

4) two APs; and

5) one IRU.

b) **Design assurance**.- The system design assurance must be consistent with at least one severe or major failure condition due to loss of lateral or vertical guidance during an RNP AR APCH where an RNP value of less than 1.0 is required to avoid obstacles and terrain while executing a missed approach.

Note.- *The loss of lateral guidance display during RNP AR APCH missed approach operations that require an RNP value of less than 1.0 to avoid obstacles or terrain is considered as a hazardous (severe or major) failure condition. The AFM shall document designated systems that are consistent with this effect. This documentation shall describe the specific aircraft configuration or operation mode to obtain RNP values of less than 1.0. Compliance with this requirement may substitute the general requirement for two pieces of equipment described above.*

c) **Go-around guidance**.- Once initiated a missed approach or go-around (through the activation of TOGA or other means), the flight guidance mode must remain in LNAV to enable continuous track guidance during an RF leg. If the aircraft does not provide this capability, the following requirements apply:

1) If the aircraft provides the ability for RF legs, the lateral path after initiating a go-around (TOGA) (taking into account a straight segment of at least 50 seconds between the point where the RF leg ends and the decision altitude (DA)), must be within 1º of the track defined by the straight segment through the DA point. The previous turn may have an arbitrary angular extension and a turn radius as small as 1 NM, with speeds consistent with approach conditions and turn radius.

2) The flight crew must be capable of coupling the AP or DF to the RNP system (connect LNAV) at 400 ft AGL.

d) **Loss of GNSS.-** After initiating a go-around or a missed approach following a loss of GNSS, the aircraft must automatically revert to another means of navigation that complies with the RNP value.

APPENDIX 3

NAVIGATION DATA VALIDATION PROGRAM

1. INTRODUCTION

The procedure stored in the navigation database defines the aircraft lateral and vertical guidance. Navigation database updates are done every 28 days. The navigation data used in each update are critical for the integrity of each RNP AR APCH procedure. Taking into account the reduced obstacle clearance associated with these approaches, navigation data validation requires special consideration. This appendix provides guidance on operator procedures to validate navigation data associated with RNP AR APCH operations.

2. DATA PROCESSING

a) In its procedures, the operator shall identify the person responsible for the navigation data updating process.

b) The operator must document a process to accept, verify, and load the navigation data into the aircraft.

c) The operator must place its documented data process under configuration control.

3. INITIAL DATA VALIDATION

The operator must validate each RNP AR APCH procedure before flying the procedure under instrument meteorological conditions (IMC) to ensure compatibility with the aircraft and make sure that the resulting paths correspond to the published procedure. The operator must at least:

a) compare the navigation data of the procedure to be loaded into the FMS with a published procedure.

b) validate the navigation data of the loaded procedure, either in the flight simulator or in the aircraft under visual meteorological conditions (VMC). The procedure outlined in a map display must be compared to the published procedure. The complete procedure must be flown to make sure that the path can be used, has no apparent lateral or vertical path inconsistencies, and is consistent with the published procedure.

c) Once the procedure is validated, a copy of the validated navigation data must be kept and maintained for comparison with subsequent data updates.

4. DATA UPDATES

Whenever a navigation data update is received and before using such data in the aircraft, the operator must compare the update with the validated procedure. This comparison must identify and resolve any discrepancy in the navigation data. If there are significant changes (any change affecting the approach path or performance) to any part of a procedure, and such changes are verified through the initial information data, the operator must validate the amended procedure in accordance with the initial data validation.

5. NAVIGATION DATA SUPPLIERS

Navigation data providers must have a letter of acceptance (LOA) in order to process these data (*e.g.,* FAA AC 20-153, Conditions for issuance of letters of acceptance for navigation data suppliers by the European Aviation Safety Agency – EASA or equivalent document). An LOA recognizes the data of a supplier as those where the quality of the information, the integrity and quality management practices are consistent with the criteria of document DO-200A/ED-76. The operator's database supplier must have an

LOA Type 2 and its respective suppliers must have an LOA Type 1 or 2. AAC may accept a LOA submitted by navigation data providers or submit its own LOA.

6. AIRCRAFT MODIFICATIONS (DATA BASE UP TO DATE)

If an aircraft system required for RNP AR APCH operations is modified (*e.g.*, software change), the operator is responsible for validating the RNP AR APCH procedures with the navigation database and the modified system. This may be accomplished without any direct evaluation if the manufacturer verifies that the modification has no effect on the navigation database or path computation. If there is no such verification by the manufacturer, the operator must conduct an initial navigation data validation with the modified system.

APPENDIX 4

OPERATING PROCEDURES

1. GENERAL

This appendix provides guidance on the execution of RNP AR APCH operations. In addition to the guidelines provided in this appendix, the operator must ensure continuous compliance with the general RNP AR APCH operating procedures and verification of notices to airmen (NOTAMs), NAVAID availability, aircraft system airworthiness, and flight crew qualification.

2. PRE-FLIGHT CONSIDERATIONS

a) **Minimum equipment list (MEL).-** The operator MEL must be developed or revised to indicate equipment requirements for instrument RNP AR APCH procedures. Guidance on these equipment requirements is available in the documents of the aircraft manufacturer. The required equipment may depend on the intended navigation precision and whether the missed approach requires an RNP value of less than 1.0. For example, GNSS and AP are normally required for a low navigation precision. Normally, dual equipment is required for approaches when using a line of minima of less than RNP 0.3 and/or when the missed approach has an RNP value of less than 1.0. An operable enhanced ground proximity warning system (EGPWS/TAWS) is required for all RNP AR APCH procedures. It is advisable that the EGPWS/TAWS use local pressure- and temperature-compensated altitudes (*e.g.,* a corrected GNSS and barometric altitude) and that it includes data on significant obstacles and terrain. The flight crew must be aware of the equipment requirement.

b) **Autopilot (AP) and flight director (FD).-** For procedures with a navigation precision of less than RNP 0.3 or with RF legs, the use of AP and FD driven by the aircraft RNP system is required in all cases. Therefore, the AP and FD must operate with a suitable precision to track the lateral and vertical paths required by a specific RNP AR APCH procedure. When the dispatch or release of a flight is predicated on flying an RNP AR APCH approach that requires the use of AP at the destination and/or alternate aerodrome, the flight dispatcher or pilot in command must make sure that the AP is installed and operational.

c) **Assessment of an RNP AR APCH dispatch or release.-** The operator must have a predictive performance capability to forecast whether the specific RNP will be available at the location and time of a desired RNP AR APCH operation. This capability can be provided through a ground service and does not need to reside in the aircraft avionic equipment. The operator must establish procedures requiring the use of this capability as a dispatch or release tool and as a flight-tracking tool in case of reported failures. RNP assessment must consider the specific combination of aircraft capabilities (sensors and integration).

   1) **Assessment of RNP AR APCH with GNSS updating**.- The predictive capability must take into account known and predicted temporary suspension of GNSS satellite service or other negative effects on navigation system sensors. The prediction program shall not use a masking angle of less than 5º, as operational experience indicates that satellite signals at low elevations are not reliable. The prediction must use the current GPS constellation with an algorithm identical to that used in the on-board equipment. For RNP AR APCH procedures in high terrain, the operator must use a masking angle appropriate to the terrain.

   2) From the initiation of the approach, RNP AR APCH procedures require GNSS updating.

d) **NAVAID exclusion**.- The operator must establish procedures to exclude air navigation facilities in accordance with published NOTAMs (*e.g.,* DMEs, VORs, and localizers). Rationality checks of the internal avionic equipment may not be appropriate for RNP AR APCH operations.

e) **Validity of the navigation database**.- Upon initiating the system, the pilots of aircraft equipped with certified RNP systems must confirm that the navigation database is valid. The databases are expected to be current for the duration of the flight. If the AIRAC cycle changes during the flight, the operators and pilots must establish procedures to ensure the precision of navigation data, including the suitability of navigation facilities used for defining routes and flight procedures. Traditionally, this has been accomplished by verifying electronic data against paper documents. One acceptable means is to compare aeronautical charts (new and old) to verify navigation fixes prior to flight dispatch or release. If an amended chart has been published for the procedure, the navigation database must not be used to conduct the operation.

3. FLIGHT CONSIDERATIONS

a) **Flight plan modification**.- Pilots are not authorized to fly a published RNP AR APCH procedure unless it can be retrieved by its name from the navigation database and conforms to the published procedure. The lateral path must not be modified, except that the pilot may accept a clearance to fly direct to a fix located prior the FAF in the approach procedure, and that does not immediately precede an RF leg. The only other acceptable modification to the loaded procedure is to change speed and/or altitude waypoint constraints on the initial, intermediate, or missed approach segments (for example, corrections applied due to cold temperature or to comply with an ATC clearance/instruction).

b) **Required equipment list**.- The flight crew must have a list of the equipment required to conduct RNP AR APCH procedures or alternate methods for addressing, during the flight, equipment failures that hinder the execution of an RNP AR APCH procedure (*e.g.,* the quick reference handbook - QRH).

c) **RNP AR APCH management**.- Flight crew operating procedures must ensure that the navigation system uses the appropriate navigation precision during the approach. If the approach chart shows several minima associated to different navigation precision values, the flight crew must confirm that the desired navigation precision has been entered in the RNP system. If the RNP system does not extract and set the navigation precision from the on-board database for each leg of the procedure, then the flight crew operating procedures must ensure that the lowest navigation precision required to complete the approach or missed approach has been selected before starting the approach.

d) **GNSS updating**.- From the beginning of the approach, all instrument RNP AR APCH procedures require GNSS updating of the navigation position solution. The flight crew must verify that GNSS updating is available before starting the RNP AR APCH procedure. If at any time during the approach GNSS updating is lost and the navigation system does not have the performance to continue the approach, the flight crew must abandon the RNP AR APCH procedure, unless the pilot has in sight the visual references required to continue such approach.

e) **Radio updating**.- The initiation of any RNP AR APCH procedure is based on GNSS updating. Except where specifically designated in a procedure as not authorized, DME/DME updating can be used as a reversal mode during the approach or missed approach when the system complies with the navigation precision. VOR updating is not authorized at this time. Consequently, the flight crew must follow operator procedures to inhibit specific facilities (see paragraph 2.d) of this appendix).

f) **Approach procedure confirmation**.- The flight crew must confirm that the correct procedure has been selected. This procedure includes the confirmation of waypoint sequence, the rationality of track angles and distances, and any other parameter that can be modified by the pilot, such as altitude and speed constraints. A procedure must not be used if validity of the navigation database is in doubt. A navigation system text display or a navigation map display can be used.

g) **Track deviation monitoring**.- Pilots must use a lateral deviation indicator, an FD and/or an AP in lateral navigation mode during RNP AR APCH procedures. Pilots of aircraft with lateral deviation indicators must ensure that indicator scaling (full-scale deflection) is suitable for the navigation precision associated with the various segments of the RNP AR APCH procedure.

All pilots are expected to maintain route centre lines, as depicted by on-board lateral deviation indicators and/or in the flight guidance, during all RNP operations, unless authorized to deviate by the ATC or under emergency conditions.

For normal operations, the cross-track error/deviation (the difference between the path estimated by the RNP system and the aircraft position relative to the path) shall be limited to ± ½ the navigation precision associated with the procedure segment.

Small lateral deviations from this requirement (*e.g.,* overshooting or undershooting the limit) during or immediately after a turn are allowed, up to a maximum of 1 times (1xRNP) the navigation precision of the procedure segment.

The vertical deviation must be within 75 ft during the final approach segment. Lateral deviations shall be monitored above and below the glide path (GP). While being above the glide path provides a margin over the obstacles during the final approach, it can result in the pilot deciding to do a go-around closer to the runway, which reduces obstacle clearance during the missed approach.

Pilots must execute a missed approach if lateral deviation exceeds 1xRNP or if vertical deviation exceeds 75 ft, unless the pilot has in sight the visual references required to continue the approach.

1) Some aircraft navigation displays do not incorporate lateral and vertical deviations scaled for each RNP AR APCH operation in the primary field of view of the pilot. When using a moving map, a low-resolution vertical deviation indicator (VDI), or a numeric deviation display, flight crew training and procedures must ensure the effectiveness of these displays. Normally, this implies a demonstration of the procedure with a number of trained crews and the inclusion of this monitoring procedure in the recurrent training program for RNP AR APCH.

2) For aircraft using a CDI for lateral path tracking, the AFM or the aircraft qualification guidance shall indicate which navigation precision (RNP value) and operations the aircraft supports and the effects of the operation on CDI scale. The flight crew must know the CDI full-scale deflection (FSD) value. The avionics system can automatically adjust the CDI scale (depending on the flight phase) or the flight crew can manually adjust such scale. If the flight crew manually selects the CDI scale, the operator must have procedures in place and provide training to ensure that the CDI scale selection is appropriate for the intended RNP AR APCH operation. The deviation limit must be readily visible, considering CDI scale (*e.g.,* full-scale deflection).

h) **System cross-check**.- For RNP AR APCH procedures with a navigation precision of less than 0.3, the flight crew must monitor the lateral and vertical guidance provided by the RNP navigation system to ensure that this guidance is consistent with other available data and displays provided by an independent means.

Note.- *This cross-check may not be necessary if lateral and vertical guidance systems have been developed taking into account a hazardous (severe or major) failure condition due to false information (see Appendix 2, paragraph 3.e) and if normal system performance supports airspace containment (see Appendix 2, paragraph 2.d).*

i) **Procedures with RF legs**.- An RNP AR APCH procedure may require that aircraft be capable of executing an RF leg to avoid terrain and obstacles. Since not all aircraft have this capability, flight crews must know whether or not they can conduct these procedures. When flying an RF leg, flight crew compliance with the flight path is essential to maintain the track defined on the ground.

1) If a go-around maneuver is initiated during or immediately after an RF leg, the flight crew must be aware of the importance of maintaining the published path as closely as possible. The operator must develop and establish operating procedures for aircraft that do not stay in LNAV when a go-around maneuver is initiated, to ensure that the RNP AR APCH track defined on the ground is maintained.

2) Pilots must not exceed the maximum speeds shown in Table 4-1 during the RF leg. For example, an A 320 Category C must slow down to 160 KIAS at the final approach fix (FAF) or can fly as fast as 185 KIAS if using Category D minima. A missed approach prior to the decision altitude (DA) may require a segment speed for that segment to be maintained.

Table 4-1 – Maximum speed by segment and category

Indicated Airspeed (Knots)					
Segment	Indicated airspeed by aircraft category				
	Cat A	Cat B	Cat C	Cat D	Cat E
Initial and intermediate (IAF to FAF)	150	180	240	250	250
Final (FAF to DA)	100	130	160	185	As specified in the IAC
Missed approach (DA to MAHP)	110	150	240	265	As specified in the IAC
Airspeed restriction*	As specified in the IAC				

* Airspeed restrictions may be used to reduce turn radius regardless of aircraft category.

j) **Temperature compensation**.- For aircraft with temperature compensation capability as per paragraph 3.a)7) of Appendix 2 to this CA, flight crews may disregard temperature limits for RNP AR APCH procedures if the operator provides flight crews with training on the use of this capability. Temperature compensation through the aircraft system is applicable to VNAV guidance and is no substitute for flight crew compensating for cold temperature effects at minimum altitudes or the decision altitude. Flight crews must be familiar with the effects of temperature compensation when intercepting the compensated path described in documents EUROCAE ED-75B/RTCA DO-236B Appendix H.

k) **Altimeter setting**.- Due to reduced obstacle clearance inherent to instrument RNP AR APCH procedures, the flight crew must verify that the current local altimeter is set prior to the FAF but not prior to the IAF. The execution of an instrument RNP AR APCH procedure requires that the current altimeter be set for the aerodrome of intended landing. Remote altimeter settings are not allowed.

l) **Altimeter cross-check**.- Prior to the FAF, but not before the IAF, the flight crew must carry out a cross-check of both pilot altimeters to make sure they agree within ± 100 ft. If the cross-check fails, the crew must not continue with the approach. If the avionics system provides an automatic altitude comparison warning system for pilot altimeters, flight crew procedures shall indicate the action to be taken in the event of an altimeter comparator warning while executing an RNP AR APCH.

Note.- *This operational cross-check is not required if the aircraft system automatically compares altitudes to within 100 ft (see paragraph 3. d)15) of Appendix 2).*

m) **VNAV altitude transitions**.- The aircraft VNAV barometric system provides fly-by vertical guidance to ensure a smooth transition when intercepting the glide path prior to the FAF. Small vertical shifts, which may occur in a vertical constraint (*e.g.,* in the FAF), are considered operationally acceptable and desirable since they allow for the capture of a new or the next vertical segment. This temporary deviation below the published minima is acceptable as long as the deviation is limited to no more than 100 ft and is the result of a normal VNAV capture. This applies to both "leveling" and "altitude capture" segments that follow a climb or descent or vertical climb or beginning of a segment with descent, or when climb and descent paths with different slopes come together.

n) **Non-standard climb gradient**.- When the operator intends to use a DA associated with a missed approach non-standard climb gradient, it must ensure that the aircraft will be able to comply with the climb gradient published for the expected weight (mass) of the aircraft, atmospheric conditions, and operating procedures before conducting the operation. When the operator has performance personnel available to determine whether its aircraft can meet the published climb gradients, such personnel must provide information to pilots about the climb gradients that they must comply with.

o) **Engine-out procedures**.- Aircraft may demonstrate an acceptable flight technical error (FTE) with one engine inoperative when conducting RNP AR APCH procedures. Otherwise, flight crews are expected to take appropriate action in case of an engine failure during an approach, so no specific aircraft qualification is required in this case. The aircraft qualification must identify any performance limitation in case of engine failure to support the definition of the appropriate flight crew procedures.

Operators must pay special attention to published procedures with non-standard climb gradients.

p) **Missed approach or go-around**

1) **Missed approach procedure requiring RNP 1.0**.- Where possible, the missed approach will require RNP 1.0. The missed approach of these procedures is similar to the missed approach of an RNP APCH operation.

2) **Missed approach procedures requiring RNP of less than 1.0**.- When necessary, RNP values of less than 1.0 will be used in the missed approach. For an operator to be approved to execute these approaches, the equipage and procedures must meet the criteria established in paragraph 6 of Appendix 2 (Requirements for missed approaches with an RNP of less than 1.0).

3) In many aircraft, a change may occur in lateral navigation when TOGA is activated during a missed approach or go-around. Also, in many aircraft, TOGA activation disconnects the AP and FD from LNAV guidance, and the FD reverts to track-hold derived from the inertial system. LNAV guidance to the AP and FD shall be re-engaged as quickly as possible.

4) Flight crew procedures and training programs must address the impact on navigation capability and flight guidance if the pilot initiates a go-around during a turn. In the event an early missed approach is initiated, the flight crew must follow the approach and missed approach tracks unless otherwise cleared by the ATC. The flight crew shall also be aware that RF legs are designated based on the maximum true speed at normal altitudes, and initiating an early missed approach will reduce the maneuverability margin, and will potentially make it impractical to hold the turn at missed approach speeds.

5) Upon loss of GNSS updating, the RNP guidance may begin to navigate on IRU, if installed on the aircraft, but the aircraft will begin to drift, degrading the navigation position solution. Therefore, when RNP AR APCH missed approach operations are based on IRU autonomous navigation, the inertial guidance can only provide RNP guidance for a specific amount of time.

q) **Contingency procedures**

1) **Failure while en route**.- The aircraft RNP capability is dependent upon operational equipment and GNSS satellites. Before initiating the approach, the flight crew must be capable of assessing the impact of equipment failure on the RNP AR APCH procedure and take the appropriate corrective action. As stated in paragraph 2.c) of this appendix, the flight crew must also be capable of assessing the impact of changes in GNSS constellation and take appropriate corrective action.

2) **Failure on approach**.- The operator contingency procedures must cover at least the following conditions:

(a) RNP system components failures, including those affecting lateral and vertical deviation performance (*e.g.,* failures of GPS sensors, AP or FD).

(b) Loss of navigation signal-in-space (loss or degradation of external signal).

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APPENDIX 5

TRAINING PROGRAM

1. INTRODUCTION

The operator must provide training for key personnel on the use and application of RNP AR APCH procedures (for example, flight crews, flight dispatchers, performance engineers, and maintenance personnel). A full understanding of operating procedures and best practices is crucial for safe aircraft operation during RNP AR APCH procedures. The training program must provide sufficient detail on aircraft navigation and flight control systems to enable the flight crew to identify failures affecting their RNP capability and apply the appropriate normal, non-normal, and emergency procedures. The required training must include both knowledge and evaluation of skills acquired by flight crews, flight dispatchers, performance engineers, and maintenance personnel.

a) **Flight crew training**

1) Each operator is responsible for providing flight crews with training on the specific RNP AR APCH operations it conducts. The operator must include training on the various types of RNP AR APCH procedures and the equipment required. Training must include a discussion of regulatory requirements. The operator must include these requirements and procedures in its operating and training manuals as applicable. This material must address all aspects of RNP AR APCH procedures conducted by the operator, including the applicable operational authorization (*e.g.,* operational specifications (OpSpecs)). An individual must have completed the appropriate ground and/or flight training segments before participating in RNP AR APCH procedures.

2) Flight training segments must include training and verification modules representative of the type of RNP AR APCH operations the operator conducts during airline activities. Many operators can provide training in RNP AR APCH procedures in accordance with the training provisions and standards established by advanced qualification programs (AQP). Operators can also do assessments in line-oriented flight training (LOFT) and selected-event training (SET) scenarios or in a combination of both. The required flight training modules can be conducted in flight training devices (FTD), flight simulators, and other enhanced training devices, as long as these training media accurately replicate operator equipment and RNP AR APCH operations, and are CAA-approved.

b) **Qualification training for LAR 91, 121, and 135 flight crews**

1) Operators must refer to RNP AR APCH training and qualification modules during initial, transition, upgrade, recurrent, discrepancy, re-qualification, and autonomous (self-teaching) training, in accordance with the approved training programs. The skill of each pilot to understand and properly use RNP AR APCH procedures will be assessed based on qualification standards (initial RNP AR APCH assessment). The operator must also develop recurrent qualification standards to ensure its flight crews properly maintain their knowledge of, and proficiency in RNP AR APCH operations (RNP AR APCH recurrent qualification).

2) Operators may address RNP AR APCH topics separately or integrated with other curriculum elements. For example, a flight crew qualification may focus on a specific aircraft during transition, upgrade, or discrepancy courses. General training must also address RNP AR APCH qualification (*e.g.,* during recurrent training or verification events such as proficiency checks (PC), proficiency training (PT), line-oriented evaluations (LOE), or special-purpose operational training (SPOT)). A separate, independent RNP AR APCH qualification program can also address RNP AR APCH training (*e.g.,* by completion of a special RNP AR APCH curriculum at an operator training centre or designated crew bases).

3) **Credit for using the approved RNP training program of an operator in service**.- Operators intending to receive credit for RNP training, when their proposed program relies on previous RNP training (for example, special instrument approach procedures (IAPs)), must

receive specific authorization from their principal operations inspector (POI). In addition to the current RNP training program, the operator must provide training on discrepancies between the existing training program and RNP AR APCH training requirements.

4) **Flight dispatcher training**

(a) Training for flight dispatchers must include:

(1) training on the different types of RNP AR APCH procedures;

(2) the importance of specific navigation and other equipment during RNP AR APCH operations, and regulatory RNP AR APCH procedures and requirements.

(b) Flight dispatcher procedures and training manuals must include the requirements of paragraph (a) above.

(c) Training must also cover all aspects of RNP AR APCH operations conducted by the operator, including applicable authorizations (*e.g.,* OpSpecs, operations manual, LOA).

(d) A dispatcher must have completed the appropriate training course before participating in RNP AR APCH operations.

(e) Additionally, dispatcher training must address how to determine:

(1) RNP AR APCH availability (taking into account equipment capabilities);

(2) MEL requirements;

(3) aircraft performance; and

(4) navigation signal availability (*e.g.,* GPS RAIM, RNP capability predictive tools) for destination and alternate aerodromes.

2. GROUND TRAINING SEGMENTS

The ground segment of the RNP AR APCH training program must include modules addressing the following subjects during the initial introduction of RNP AR APCH operations and systems for flight crews. For recurrent training programs, the training curriculum needs only to review the initial curriculum requirements and address new, revised, or emphasized aspects of RNP AR APCH operations.

a) **General concepts of RNP AR APCH operations**.- RNP AR APCH academic training must address the theory behind RNP AR APCH systems to the extent appropriate to ensure proper operational use. Flight crews must understand the basic operational concepts of RNP AR APCH systems, its classifications and limitations. Training must include general knowledge and operational application of instrument RNP AR APCH procedures. This training module must address the following specific elements:

1) definition of RNAV, RNP, RNP AR APCH;

2) the difference between RNAV and RNP;

3) the types of RNP AR APCH procedures and familiarity with the charts for these procedures;

4) RNP programming and display and aircraft-specific displays (*e.g.,* current navigation performance);

5) how to enable and disable RNP-related navigation updating modes;

6) the appropriate navigation precision for the different flight phases and RNP AR APCH procedures, and how to select it (if required);

7) the use of GPS RAIM (or equivalent) forecasts and the effects of RAIM availability on RNP AR APCH procedures (flight crews and dispatchers);

8) when and how to terminate RNP navigation and transfer to traditional navigation due to loss of RNP and/or the required equipment;

9) how to determine database validity and whether it contains the required navigation data for using waypoints;

10) explanation of the different components that contribute to the total system error and their characteristics (*e.g.,* the effect of temperature on barometric vertical navigation (baro-VNAV), drift characteristics when using IRU with no radio updating);

11) Temperature compensation. Flight crews operating avionics systems with a compensation function may disregard temperature limits on RNP AR APCH procedures if the operator provides flight crew training on the operation of such function and crews use the function. The training must indicate that temperature compensation through the aircraft system is applicable to VNAV guidance and is not a substitute for flight crew compensating for cold temperature effects on minimum altitudes or the decision altitude.

Note 1.- *Pilots are responsible for all low (cold) temperature corrections required at all published minimum altitudes/heights. This includes:*

- altitudes/heights for initial and intermediate legs;
- the DA/H; and
- subsequent missed approach altitudes/heights.

Note 2.- *The VPA of the final approach path is protected against the effect of low temperatures by the procedure design.*

b) **ATC communications and coordination for conducting RNP AR APCH operations**.- Ground training must instruct the flight crew on flight plan classification, any ATC procedure applicable to RNP AR APCH operations, and the need to advise ATC immediately when the performance of the aircraft navigation system is no longer suitable to support continuation of an RNP AR APCH procedure. The flight crew must know that navigation sensors are part of the basis for RNP AR APCH compliance, and must be capable of assessing the impact of failure of any avionics equipment or ground navigation systems and services on flight plan compliance.

c) **RNP AR APCH equipment components, controls, displays, and alerts**.- Academic training must cover RNP terminology, symbols, operation, optional controls, and display features, including aspects that are specific to the operator implementation or systems. Training must address applicable alerts and limitations. Flight crews and dispatchers should achieve full understanding of the equipment used in RNP operations and any limitations on the use of the equipment during these operations.

d) **AFM operating procedures and information**.- The AFM or other evidence of aircraft eligibility must address normal and non-normal flight crew operating procedures, responses to failure alerts, and any limitation, including information related to RNP modes of operation. Training must also address contingency procedures for loss or degradation of RNP capability. The accepted or approved operations manuals, including the aircraft operations manual (AOM/FCOM) and the pilot operations handbook (POH), must contain this information in the corresponding sections.

e) **MEL provisions**.- Flight crews must have a full understanding of MEL requirements supporting RNP AR APCH operations.

3. FLIGHT TRAINING SEGMENTS

In addition to academic training, flight crews must receive appropriate operational training. Training programs must address the proper execution of RNP AR APCH procedures according to the documentation of the original equipment manufacturer (OEM). The operational training must include RNP AR APCH procedures and limitations, standardization of cockpit electronic display configuration during an RNP AR APCH procedure, recognition of aural warning signals, alerts, and other annunciations that can affect compliance of an RNP AR APCH procedure, and timely and effective responses to loss of RNP AR APCH capability in a variety of scenarios embracing the breadth of RNP AR APCH procedures that the operator plans to execute. Flight training may use approved FTDs or flight simulators. This training must include the following specific elements:

a) procedures for verifying that each pilot altimeter has a valid setting before initiating the final approach in an RNP AR APCH procedure, including any operational limitations associated with the source(s) for altimeter setting and the latency of checking and setting the altimeters upon approaching the FAF;

b) use of RADAR, EGPWS (TAWS), or other avionics systems to support track monitoring and avoidance of obstacles and adverse weather by the flight crew;

c) the effect of wind on aircraft performance during RNP AR APCH procedures and the need to remain within the containment area, including any operational limitations due to wind, and the essential aircraft configuration to safely complete an RNP AR APCH procedure;

d) the effect of ground speed on compliance with RNP AR APCH procedures, and bank angle constraints that hinder the ability to remain on the centre line of the course;

e) the relationship between RNP and the appropriate line of approach minima on a published RNP AR APCH procedure, and any operational limitation if the available RNP degrades o is not available prior to the approach (this includes flight crew procedures outside the FAF *versus* inside the FAF);

f) complete and concise flight crew briefings on all RNP AR APCH procedures and the important role cockpit resource management (CRM) plays on successfully completion of an RNP AR APCH procedure;

g) data insertion alerts and use of a wrong navigation precision for a desired segment of an RNP AR APCH procedure;

h) performance requirements for coupling the AP/FD to the navigation system lateral guidance on RNP AR APCH procedures requiring an RNP of less than 0.3;

i) the importance of aircraft configuration to ensure that it maintains any required speed during RNP AR APCH procedures;

j) the events that trigger a missed approach when using aircraft RNP capability;

k) any bank angle constraint or limitation on RNP AR APCH procedures;

l) the potentially detrimental effect of reducing flap setting, reducing the bank angle, and increasing airspeed on the ability to comply with an RNP AR APCH procedure.

m) the knowledge and skills required by the flight crew to properly conduct RNP AR APCH operations;

n) the programming and operation of the FMC, AP, auto-throttles, RADAR, GPS, INS, EFIS (including a moving map), and EGPWS (TAWS) in support of RNP AR APCH procedures;

o) the effect of activating TOGA during a turn;

p) FTE monitoring and its effect on go-around decision and execution;

q) loss of GNSS during a procedure;

r) performance aspects associated with reversal to radio position updating, and limitations on the use of DME and VOR updating;

s) flight crew contingency procedures for loss of RNP capability during a missed approach. Due to lack of navigation guidance, training must emphasize the contingency actions that the flight crew must take to achieve separation from the ground and obstacles. The operator must tailor these contingency procedures to the specific RNP AR APCH procedures;

t) as a minimum, each pilot must complete two RNP AR APCH procedures using the unique characteristics of the approved procedures of the operator (*e.g.,* RF legs, loss of RNP). One procedure must culminate in a transition to landing and another procedure must culminate in the execution of an RNP missed approach procedure.

4. EVALUATION MODULE

a) **Initial evaluation of RNP AR APCH procedures and knowledge**.- The operator will evaluate the knowledge that each member of the flight crew has with respect to RNP AR APCH procedures before they use these procedures. As a minimum, this must include a complete evaluation of pilot procedures and the specific performance requirements for RNP AR APCH operations. An acceptable means for this initial evaluation includes one of the following:

1) An evaluation by an authorized instructor evaluator or an operator inspector, using an simulator or training device.

2) An evaluation by an authorized instructor evaluator or an operator inspector during on-line operations, training flights, proficiency check (PC) or proficiency training (PT) events, operational experience (OE), en-route checks and/or on-line checks.

3) Line-oriented flight training (LOFT)/line-oriented evaluation (LOE).- LOFT/LOE training programs using an approved simulator that incorporates RNP operations with the unique RNP AR APCH characteristics (*e.g.,* RF legs, loss of RNP) of the approved procedures of the operator.

b) **Specific elements of the evaluation module.-** The specific elements that must be included in the evaluation module are:

1) Demonstrate the use of any RNP limits/minima that might affect various RNP AR APCH operations.

2) Demonstrate the application of position radio updating procedures, such as enabling and disabling FMC ground-based radio updating (*e.g.,* DME/DME and VOR/DME updating), and knowledge of when to use this feature. If aircraft avionics does not include the capability of disabling radio updating of the position, then training must ensure the flight crew is capable of adopting operational measures to mitigate the lack of this feature.

3) Demonstrate the ability to monitor the lateral and vertical flight paths relative to the programmed flight path, and complete the appropriate flight crew procedures when exceeding an FTE lateral or vertical limit.

4) Demonstrate the ability to read and interpret a RAIM (or equivalent) forecast, including forecasts predicting RAIM unavailability.

5) Demonstrate how to properly configure the FMC, the weather RADAR, EGPWS (TAWS), and the moving map for the various RNP AR APCH operations and scenarios that the operator intends to implement.

6) Demonstrate the use of flight crew briefings and checklists for RNP AR APCH operations, with emphasis on CRM.

7) Demonstrate knowledge and skills to conduct an RNP AR APCH missed approach procedure in a variety of operating scenarios (*e.g.,* loss of navigation or failure to obtain visual conditions).

8) Demonstrate speed control during segments requiring speed restrictions to ensure compliance with the RNP AR APCH procedure.

9) Demonstrate proficient use of instrument approach charts (IAC), briefing cards, and checklists.

10) Demonstrate the ability to complete a stable RNP AR APCH procedure: bank angle, speed control, and staying on the centre line of the procedure.

11) Know the operational limit for deviations below the desired flight path on an RNP AR APCH procedure and how to precisely monitor the aircraft position relative to the vertical path.

5. RECURRENT TRAINING ON RNP AR APCH KNOWLEDGE AND PROCEDURES

a) **RNP AR APCH recurrent training**.- In its training program, the operator must incorporate recurrent RNP training and evaluation covering the unique characteristics of RNP AR APCH operations with respect to the approved procedures.

b) Each pilot must fly a minimum of two RNP AR APCH procedures in each duty position (pilot flying the aircraft (PF) and pilot monitoring the aircraft (PM)), with one approach culminating in a complete landing and one culminating in a missed approach.

__Note.-__ Equivalent RNP approaches may be credited toward compliance of the requirement for two RNP AR APCH procedures.

APPENDIX 6

RNP AR APCH MONITORING PROGRAM

1. The operator must have an RNP AR APCH monitoring program to ensure continued compliance with the guidelines of this AC and to identify any negative performance trends. As a minimum, the monitoring program will include the following activities: During the provisional approval, the operator must submit the following information every 30 days to the authority that issued the authorization. Subsequently, it will continue collecting information and periodically reviewing it to identify potential safety risks. It will also maintain a summary of the processed information.

a) Total number of RNP AR APCH procedures executed.

b) Number of satisfactory approaches per aircraft and system (they are considered satisfactory if completed as planned without any anomalies in the navigation or guidance system).

c) Reasons for unsatisfactory approaches, such as:

   1) UNABLE REQ NAV PERF, NAV ACCUR DOWNGRAD, or other messages activated during the approach;

   2) Excessive lateral or vertical deviation;

   3) EGPWS (TAWS) warning;

   4) Disconnection of the AP system;

   5) Navigation data errors; and

   6) Reports of anomalies by the pilot.

d) Comments by the crew.

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APPENDIX 7

REQUIREMENTS FOR OBTAINING RNP AR APCH AUTHORIZATION

In order to obtain operational approval, the operator will take the following steps, taking into account the criteria established in paragraphs 7, 8, 9, and 10 and in Appendices 2, 3, 4, 5, 6, 8, and 9 to this AC.

a) *Airworthiness approval*.- Aircraft shall have the corresponding airworthiness approvals as established in paragraphs 8 and 9 of this AC.

b) *Application*.- The operator shall submit the following documentation to the CAA:

1) *The application to obtain an RNP AR APCH authorization*.

2) *Aircraft qualification documentation*.- The documentation of the manufacturer demonstrating that the proposed aircraft equipment meets the requirements of this AC as described in Appendix 2. This documentation shall contain hardware and software requirements, procedural requirements, and limitations.

3) *Type of aircraft and description of aircraft equipment to be used*.- The operator will provide a configuration list with details of the relevant components and the equipment to be used in the operation. The list shall include each manufacturer, model, and version of software installed in the FMS.

4) *Operational procedures and practices*.- The operator manuals must properly describe the characteristics of the intended area of operation and operational (navigation) practices and procedures identified in Appendix 4 to this AC. LAR 91 operators shall confirm that they will operate using identified practices and procedures.

5) *Navigation data validation program*.- The details of the navigation data validation program are described in Appendix 3 to this AC.

6) *Flight crew training program*.- According to Appendix 5 to this AC, operators must submit the training syllabi and other appropriate teaching material to demonstrate that operations have been incorporated into their programs. Training programs must properly address the special characteristics of the intended area of operation and (navigation) operational practices and procedures identified in Appendix 4 to this AC.

7) *Flight simulator training*.- Operators must submit a description of the training to be provided using simulation, the credits to be granted to simulation, the simulator qualification, and how this training will be used for on-line pilot qualification. Normally, this training will be included in the flight crew training program.

8) *Training programs for dispatchers and flight trackers*.- Operators will submit the training syllabi and other appropriate teaching material to demonstrate that this personnel has been incorporated into its programs as established in Appendix 5 to this AC.

9) *Instruction program for maintenance program.-* Operators will submit instruction syllabus corresponding to maintenance personnel.

10) *Operation manuals and checklists*.- Operators will submit the operation manuals and checklists containing information and guidance for the operations requested.

11) *Maintenance procedures*.- The operator will submit the maintenance procedures containing airworthiness and maintenance instructions for the systems and equipment to be used in the operation. The operator will provide a procedure for withdrawing and then restoring RNP AR APCH operational capability on the aircraft.

12) *RNP AR APCH monitoring program*.- The operator must submit a program for collecting data on executed RNP AR APCH procedures. Each operation must be recorded and unsatisfactory

attempts must include the factors that prevented the successful completion of an operation.

13) *MEL*.- The operator will submit any revision to the MEL that is required for the conduction of operations.

14) *Validation*.- The operator will submit a validation test plan to demonstrate its ability to conduct the intended operation (see Chapter 13 of Volume II, Part II, of the SRVSOP Operations Inspector Manual (OIM)). The validation plan shall at least include the following:

(a) a statement that the validation plan has been designated to demonstrate the capability of the aircraft to execute RNP AR APCH procedures;

(b) the operational and dispatch procedures of the operator;

(c) the effectiveness of the operator training program;

(d) the effectiveness of maintenance procedures; and

(e) MEL procedures.

***Note 1**.- The validation plan shall benefit from ground training devices, flight simulators, and aircraft demonstrations. If validation is done on board an aircraft, it must be done during in daytime and in VMC.*

***Note 2**.- Validations may be required for each manufacturer, model and version of software installed in the FMS.*

15) *Conditions or limitations necessary or required for authorizations*.- The operator will submit any condition or limitation necessary or required for the authorizations.

16) *Flight operational safety assessment (FOSA).*- The operator will submit the methodology and process developed.

c) *Training*.- Once the amendments to the manuals, programs, and documents submitted have been accepted or approved, the operator will provide the required training to its personnel.

d) *Validation flights*.- Validation flights will be conducted in accordance with paragraph b) 13) above.

e) *Issuance of provisional authorization to conduct RNP AR APCH operations*.- Once the operator has completed the operational approval process, the CAA will issue the provisional authorization for the operator to conduct RNP AR APCH operations.

1) *LAR 91 operators*.- For LAR 91 operators, the CAA will issue a letter of acceptance (LOA) containing a provisional authorization to conduct RNP AR APCH operations according to the guidelines of this AC.

2) LAR 121 and/or 135 operators.- For LAR 121 and/or LAR 135 operators, the CAA will issue the corresponding OpSpecs reflecting the RNP AR APCH provisional authorization.

f) *Issuance of final approval*.- The CAA will issue the amended OpSpecs or the amended LOA authorizing the use of the lowest applicable minima, once the operators have satisfactorily completed the time period and the number of approaches required by the CAA, in accordance with paragraph 9.1 of this AC.

APPENDIX 8

RNP AR APCH Approval Process

a) The RNP AR APCH approval process encompasses the airworthiness and the operational approval. Although the two have different requirements, they must be considered within the same process.

b) This process constitutes an orderly method used by CAAs to ensure that applicants meet the established requirements.

c) The approval process is made up by the following phases:

1)	Phase one:	Pre-application
2)	Phase two:	Formal application
3)	Phase three:	Review of documentation
4)	Phase four:	Inspection and demonstration
5)	Phase five:	Approval

d) In *Phase one - Pre-application*, the CAA meets with the applicant or operator (pre-application meeting), who is advised of all the requirements it must meet during the approval process.

e) In *Phase two - Formal application*, the applicant or operator submits the formal application, accompanied by all the relevant documentation, in accordance with Appendix 7 to this AC.

f) In *Phase three - Review of documentation*, the CAA evaluates the documentation and the navigation system to determine their admissibility and the approval method to be applied with respect to the aircraft. As a result of this review and evaluation, the CAA may accept or reject the formal application together with the documentation.

g) In *Phase four - Inspection and demonstration*, the operator will train its personnel and implement the validation plan.

h) In *Phase five - Approval*, the CAA issues the RNP AR APCH provisional authorization once the operator has met the airworthiness and operational requirements. For LAR 121 and 135 operators, the CAA will issue the OpSpecs, and for LAR 91 operators, it will issue an LOA.

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APPENDIX 9

FLIGHT OPERATIONAL SAFETY ASSESSMENT (FOSA)

1. INTRODUCTION

The objective of RNP AR APCH procedures is to provide safe flight operations. Traditionally, safety has been defined by a target level of safety (TLS) and specified as a collision risk of 10^{-7} per approach. For RNP AR APCH operations, a different methodology, known as flight operational safety assessment (FOSA) is used. The FOSA is intended to provide a safety level that is equivalent to the traditional TLS.

With the FOSA, the safety objective is met by taking into account more than just the aircraft navigation system. The FOSA combines quantitative and qualitative analyses and evaluations of the navigation systems, aircraft systems, operational procedures, hazards, failure mitigations, normal, rare-normal and non-normal conditions, and the operational environment.

The FOSA relies on aircraft qualification, operational approval, and instrument procedure design criteria to address mostly the general technique, procedures and factors of the process. Additionally, operational expertise, technique and experience are required to conduct and complete the FOSA.

This appendix provides an overview of hazards and mitigations to assist States in applying these criteria. Safety of RNP AR APCH operations rests with the operator and the air navigation service provider (ANSP), as described in this appendix.

A FOSA must be conducted for RNP AR APCH procedures when the specific aircraft characteristics, operational environment, obstacles, etc., warrant the conduction of an additional assessment to ensure that safety objectives are met. This assessment must give proper attention to the inter-dependence of design, aircraft capability, crew procedure, and operational environment elements.

The FOSA is a key part of the operational authorization for RNP AR APCH procedures. This methodology is associated with a specific type of aircraft or a specific performance, and may be applied to a demanding environment.

2. BACKGROUND

a) La FOSA is used to make a safety case for RNP AR APCH operations. This methodology was developed in response to the following factors:

   1) System and aircraft certification and demonstration to determine their performance and capabilities are related to rules and criteria in force at a given point in time. This condition establishes a safety basis for aircraft operations. As a result, the aircraft is known to be safe if related to known airspace types, operations, and infrastructures.

   2) Throughout time, operators and ANSPs have developed new and novel operational solutions to the problems or limitations encountered in general flight operations.

   3) The implementation of new and novel procedures allows aircraft and systems to operate in a way that varies from the original design and aircraft capability approvals.

   4) In some cases, a new application or operational procedure exposes the aircraft to failures and hazards that were not considered in the basic system design and in the approval.

   5) Normally, airworthiness guidelines cannot keep pace with the new and original operational applications. The FOSA helps to address this issue.

b) The significant difference between the FOSA and other safety analysis tools is that this methodology applies a technical judgment based on combined qualitative and quantitative assessments of aircraft and flight operations. This means that the FOSA is not a safety analysis, or a risk analysis, or a risk model.

c) While the FOSA must consider risk estimates and exposures due to specific hazards and failures, the main aspect of the assessment is confidence on the technical judgment to determine acceptable mitigations for hazards or failures.

d) Although the FOSA has recently been formalized as a process in connection with RNP AR APCH operations, it has been extensively applied to assess particular cases, like the operations of a customer whose procedure design may significantly differ from the standard, and where there is a significant dependence on aircraft capability and performance. What the FOSA really offers is a process that repeats itself and a high level of standardization of case considerations and conditions.

3. DOCUMENTATION RELATED TO THE FOSA AND RNP AR APCH OPERATIONS

The FOSA is part of the total data package that must be compiled or created when an operator wishes to obtain an operational approval for RNP AR APCH procedures. Most of the aspects of the following RNP AR APCH package must be compiled or at least defined before conducting the FOSA.

a) *Aircraft capability and qualification;

b) Design of procedures, airspace, and intended operations;

c) Identification of non-standard aspects of procedure design;

d) *Identification of any special aircraft capability or performance requirements;

e) Description of the aerodrome and operation in the airspace;

f) Air traffic environment and operations;

g) *Maintenance process and procedures;

h) *Dispatch guidance and procedures;

i) *Training (flight crews, operations, air traffic, dispatch, recurrent training);

j) *Flight crew procedures;

k) *AR operations monitoring program; and

l) *Minimum equipment list

Most of the material with an asterisk (*) may have been developed to support aircraft type design or as part of the operational approval. In any case, specific acceptable means of compliance have been developed in this AC or in equivalent documents, like FAA AC 90-101 and AMC 20-26.

4. THE FOSA PROCESS

The FOSA process depends on the following factors:

a) a group of experts that includes;

  1) the operator (flight operations, dispatch, maintenance, inspectors, safety, quality system, etc.),

  2) air traffic services (ATC controller, airspace planner, principal operations inspectors, safety management, etc.);

  3) regulators; and

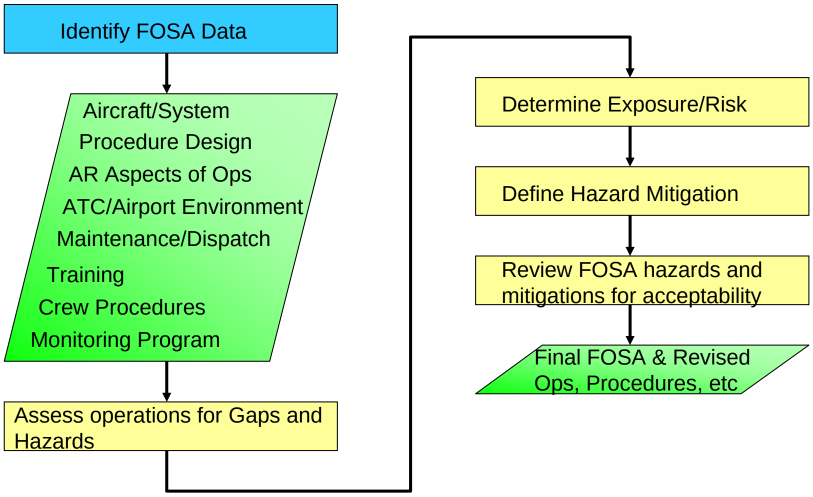
  4) experts on aircraft and system technical support.

b) a process leader capable of facilitating the guiding the review;

c) access to, or direct knowledge of the information required in paragraph 3; and

d) the process steps described in Table 9-1 – FOSA Process Steps:

Table 9-1 – FOSA Process Steps



5. FOSA PREPARATION

As documents and the data package are being organized and developed, the operator must review specific data or relevant information for the FOSA, including some of the following aspects:

a) What are the operational requirements or objectives?

b) What is the operational environment?

c) How do the aircraft operational and functional capabilities conform to procedure design requirements?

d) What specific system performance assessments and analyses have been performed to support aircraft qualification?

e) Are services and infrastructure suitable for the RNP AR APCH operation?

f) What RNP training is currently provided to flight crews and ATC?

g) What are the flight crew procedures for RNP operations?

h) How are RNP navigation specifications incorporated into ATS operations?

6. FLIGHT OPERATIONAL SAFETY ASSESSMENT (FOSA)

6.1 General.-

As part of the application package of the operator for RNP AR APCH operations, the FOSA shall contain:

a) An introduction or overview;

b) A description of the safety assessment process and criteria used;

c) A description of the system and of the RNP AR APCH operation assessed;

d) The identification of risk areas, hazards and severity;

e) Mitigation of risks; and

f) Conclusions and recommendations.

6.2 Assessment criteria.-

a) The FOSA shall identify the specific conditions or hazards associated with the aircraft, aircraft performance, navigation services, ATC, flight crew, operations of the operator, procedures, etc. In many cases, the total package of identified potential hazards will include many of the hazards already identified through aircraft certification, operator procedures, and air traffic operations.

b) Some times, the FOSA may contain several of the hazards contemplated in the aircraft system safety analysis. In this case, the assessment helps to make the safety case rather than to re-analyze aircraft airworthiness. Additionally, this reduces the probability of multiple mitigations for a risk that requires a single mitigation.

c) The FOSA applies the qualitative technique and operational experience, as well as technical judgment and relevant data availability. The assessment of findings regarding risk severity and likelihood shall follow the criteria contained in Table 9-2 – Risk severity and likelihood of success, which is based on ICAO Doc 9859 – Safety Management Manual.

Table 9-2 – Risk Severity and Likelihood of Occurrence

Risk Severity		**Likelihood of Occurrence**	
Level		**Probability**	
Catastrophic	Equipment destroyed Multiple casualties	Frequent	Likelihood of occurring many times
Hazardous	Significant reduction of safety margins, physical suffering or workload such that there can be no confidence in the operators precisely or fully performing their tasks. Several casualties or seriously injured. Significant damage to the equipment.	Occasional	Likelihood of occurring some times
Significant (Major)	Significant reduction of safety margins, reduction of operator ability to face adverse operational conditions due to an increased workload or conditions hindering efficiency. Serious incident. Injured individuals.	Remote	Not very likely, but possible.
Of little importance (Minor)	Nuisance. Operational limitations. Use of emergency procedures. Minor incident.	Unlikely	Its occurrence is very unlikely.
Negligible	Of little consequence.	Extremely unlikely	Its occurrence is almost unconceivable.

d) It is important to note that a risk assessment cannot be assumed to be always the same in each FOSA. A failure or condition considered as “major/unlikely” for an aircraft, procedure, and operational environment could be easily considered as “hazardous/remote” for another aircraft, procedure, and operational environment.

6.3 The following conditions are examples of the most significant hazards and mitigations associated to a specific aircraft, operational criterion, and RNP AR APCH operational procedures.

a) **Aircraft**

1) This area of the FOSA is derived from the safety analysis of aircraft systems, the documentation describing the system, and operational experience. The aspects to consider are as follows:

(a) Failure of the following systems:

- navigation;
- flight guidance;
- flight instruments for approach, missed approach or departure (for example, loss of GNSS updating, receiver failure, auto-pilot disconnect, FMS failure, etc.).

Note.- *Depending on the aircraft, this may be addressed in the aircraft design and operational procedures as cross-check guidance (e.g., dual equipment for lateral errors, use of EGPWS/TAWS).*

(b) Malfunction of altimetry or air data systems.- The risk can be mitigated through a cross-check procedure between two independent systems.

2) The FOSA must also consider normal, rare-normal, and non-normal conditions.

(a) Normal performance.- Lateral and vertical precision and RNP performance are addressed in aircraft requirements, in the aircraft itself, and in the systems normally operated in standard configurations and operating modes, while individual error components are monitored through the design system and crew procedures.

(b) Rare-normal and non-normal performance.- RNP lateral and vertical precision is assessed through system failures, as part of aircraft qualification. Additionally, other rare-normal and non-normal conditions, as well as ATC operating conditions, flight crew procedures, NAVAID infrastructure, and the operational environment are also assessed with respect to RNP or 2xRNP, as appropriate. When the results of a failure or condition are not acceptable for continued operations, mitigations must be developed or limitations established for the aircraft, flight crew and/or operation.

b) **Aircraft performance**

1) The RNP AR APCH procedure design criteria are linked to general aircraft performance. The result may be conservative in terms of performance margins, depending on the aircraft and the systems that have been assessed. These are the specific parameters that shall be assessed for the deviation as they relate to those in the procedure design, such as bank angle limit, climb, high altitude performance, etc.

2) *Inadequate performance to conduct the approach*.- The initial aircraft qualification and operational procedures ensure an adequate performance on each approach, as part of flight planning and to initiate or continue the approach. Consideration shall be given to aircraft configuration and any configuration change associated with a go-around (*e.g.,* engine failure, flap retraction).

3) *Loss of engine*.- Loss of an engine while conducting an RNP AR APCH procedure is a rare occurrence due to high engine reliability and the short exposure time during the approach. Operators are expected to develop flight procedures and training allowing them to take appropriate action to mitigate the effects of a loss of engine through a go-around and taking manual control of the aircraft, if necessary.

c) **Navigation services**

1) The use and availability of navigation services are critical in RNP AR APCH applications, where small RNP values are required for the approach and possible extraction maneuvers. Multi-sensor navigation systems must be assessed as to use and selection of sensors. The following must be considered:

(a) *Use of NAVAIDs outside of their designated coverage or in test mode*. Aircraft requirements and operational procedures have been developed to mitigate this risk.

(b) *Navigation database errors*.- Procedures must be validated through a validation flight specific to the operator and aircraft, and the operator must have a process defined to maintain validated data through navigation database updates.

Note.- *Navigation database assurance is covered by the letters of authorization issued by the CAAs to database manufacturers, which must be combined with operator procedures to ensure that the correct and updated databases are installed on the aircraft.*

d) **ATC operations**

1) Frequently, the ATC is not involved in the implementation of RNP AR APCH operations until it is too late. An early revision of ATC operational aspects is critical to enable RNP AR APCH procedures. In this sense, the following must be considered:

(a) Procedures assigned to an aircraft that is not RNP AR APCH capable: Operators are responsible for not accepting the authorization.

(b) The ATC provides vector guidance onto an approach whose performance cannot be achieved by the aircraft: ATC procedures and training must ensure obstacle clearance until the aircraft is established on the procedure. The aircraft shall not be guided by the ATC over or towards a point too close to the curved segments of the procedure.

e) **Flight crew operations**

1) Human factors in RNP AR APCH operations are related to an increased reliance on ground and air automation to reduce human error exposure and incidents. However, since human action and interaction are required, at least the following must be considered:

(a) Incorrect barometric altimeter setting: Is there a flight crew entry and check procedure to mitigate this risk?

(b) Incorrect procedure selection or loading.- Is there a flight crew procedure to verify that the loaded approach corresponds to the published procedure? Is there an on board display requirement?

(c) Incorrect flight control mode selection: Is there any training on the importance of the flight control mode, and an independent procedure to monitor an excessive path deviation?

(d) Incorrect RNP selection: Is there a flight procedure to check if the RNP loaded on the system corresponds to the published value?

(e) Go-around and missed approach: Assess the risk of a balked approach at or below the DA (H). Note that this does not respond to procedure design criteria.

(f) Unfavorable meteorological conditions: What is the risk of losing or significantly reducing visual reference that might result in, or require a go-around, and what would be the effect?

f) **Infrastructure**

1) Support infrastructure and services are an integral part of aircraft performance: Some aspects are already addressed in the aircraft system risk and safety analyses.

2) GNSS satellite failure: This condition is assessed during aircraft qualification to ensure that it is possible to maintain obstacle clearance, considering the low probability of failure occurrence.

3) Loss of GNSS signals: Relevant independent equipment (*e.g.,* IRU) is required for RNP AR APCH operations with RF legs and approaches where missed approach precision is less than 1 NM. Other approaches use operational procedures to approach a published track or climb over obstacles.

4) Testing of ground NAVAIDs in the vicinity of the approach: Aircraft and operational procedures are required to detect and mitigate this event.

g) **Operating conditions**

1) Certain aspects of the aerodrome and the airspace environment are reflected on the RNP AR APCH procedure design criteria. In this sense, the following must be considered:

(a) Tailwind conditions: Excessive speed on RF legs will result in inability to maintain the track. This must be addressed in the aircraft requirements for command guidance limits, inclusion of a banking maneuverability margin of 5 degrees, consideration of the effect of speed and flight crew procedures on maintenance of speeds below the maximum authorized speed.

(b) Crossed wind conditions and the effect of flight technical error: Consider that a nominal flight technical error is assessed under a variety of wind conditions, and that a flight crew procedure to monitor and limit deviations, ensures a reliable operation.

(c) Effects of extreme temperature on barometric altitude (*e.g.,* extreme cold temperatures, knowledge of local meteorological or atmospheric phenomena, upper winds, severe turbulence, etc.): The effect of this error on vertical path is mitigated by procedure design and flight crew procedures. Aircraft that have a temperature compensation system can conduct procedures regardless of the published temperature limit. The effect of this error on minimum altitude segments and on the decision altitude is addressed in an equivalent manner for all other approach procedures.

6.4 Repercussions on the proposed solutions/mitigations

a) When assessing different conditions and risks, some may fall on a range where risk or probability is not acceptable. When reviewed by the team of FOSA experts, a range of possible solutions (*e.g.,* system design, procedures, processes, etc.) may be identified, which, turned into mitigations, reduce the level of risk and/or risk incidence in such a way that risks can be considered acceptably safe for RNP AR APCH operations. The following aspects must be considered:

1) **Operations**

(a) What are the repercussions/changes for ATC, dispatch, maintenance, flight procedures (*e.g.,* knowledge of aircraft capability, RNP equipment prediction, equipment required, and specific checks, respectively).

2) **Safety/risk**

(a) How do main differences in procedure design or operational requirements associated with aircraft or operator qualification compare (*e.g.,* what aircraft or operator exceptions or limitations compare to operational or procedural requirements)?

(b) How does the certification basis apply to intended operations? For example, are the demonstrated performance (RNP), functionality, and capabilities, together with safety and risk assessments equivalent or better than that required for the operation?

(c) How are rare-normal and non-normal conditions, failures or hazards considered in the procedure design criteria, aircraft and operator qualifications, or in the added procedures or system checks?

(d) How is the safe termination of the procedure or extraction affected?

3) General applicability in RNP AR APCH operations

(a) RNP AR APCH procedures and operational requirements differ and, thus, an applicant must consider the effect of possible mitigations on the general use of RNP aircraft regarding crew training, procedures, equipment, ATC interfaces, etc.

(b) The different hazards considered in the FOSA must be summarized, together with the associated hazards and their frequency, mitigations, and the level of the mitigated hazard and its frequency. Significant factors and aspects shall be highlighted in the final recommendations (see the attached example in Table 9-3 – Example of a FOSA work sheet).

Note.- *While many aspects and questions in this appendix must be considered in the FOSA methodology, this material does not need to be included in the FOSA if reference is made in the package of the applicant.*

Table 9-3 – Example of a FOSA work sheet

Hazard identification	ID	Name	Severity	Likelihood	Description	Mitigation	Severity of the mitigation	Frequency of the mitigation	Ref. Doc.
Aircraft/system failure	A1	Engine failure	Significant	Remote	The engine failure can cause loss of separation from the ground.	A performance assessment has been done with a single engine to determine the specific performance conditions for ABC company. The crews must conduct the existing single-engine failure procedures.	Minor	Remote	PBN Manual Ch 5; 5.1
	A2	Failure of one GNSS receiver	Minor	Remote	The failure of one GPS receiver results in loss of navigation capability redundancy.	For RNP AR APCH procedures, two GNSS receivers are required. Flight crew procedures require a go-around upon failure of one GPS within the FAF. Crew procedures require a go-	Insignificant	Remote	PBN Manual Ch 5; 5.5

Hazard identification	ID	Name	Severity	Likelihood	Description	Mitigation	Severity of the mitigation	Frequency of the mitigation	Ref. Doc.
						around for all failures within the FAF, except under visual conditions.			
	A3	Incorrect flap retraction							
	A4	FMC/CDU dual failure under IMC conditions							
	A5	Degradation or loss of GPS signal							
	A6	Loss of all APs/ control mode							
	A7	Failure of two GNSS receivers							
	A8	AP disconnect							
	A9	Loss of equipment, resulting in single-system operation							

Hazard identification	ID	Name	Severity	Likelihood	Description	Mitigation	Severity of the mitigation	Frequency of the mitigation	Ref. Doc.
	A10	Air data/altimeter failure, resulting in display differences							
Operational environment (*e.g.,* physical conditions, airspace, and route design)	E1	Performance limited by tailwind							
	E2	Environmental temperature							
	E3	Strong cross-winds							
Operators	H1	Incorrect pilot response							
	H2	Poor pilot response or pilot error							
Human-machine interface	I1	Incorrect altimeter setting due to error in ATC-to-aircraft communications							
Operational procedures	P1	Temperature compensation							
	P2	Balked or rejected landing							

Hazard identification	ID	Name	Severity	Likelihood	Description	Mitigation	Severity of the mitigation	Frequency of the mitigation	Ref. Doc.
Maintenance procedure	M1	Incorrect navigation database							
External services	S1	Source-altimeter error							
	S2	ATC							
	S3	NAVAID out of coverage or in test mode							
	S4	Lack of GNSS satellite							

APPENDIX F-2

RNP AR APCH JOB AID

OPERATOR APPLICATION TO CONDUCT RNP AR APCH OPERATIONS

RNP AR APCH JOB AID

OPERATOR APPLICATION TO CONDUCT RNP AR APCH OPERATIONS

1. Introduction

This Job Aid was developed by the Latin American Regional Safety Oversight Cooperation System (SRVSOP) to provide States, operators, and inspectors with guidance on the process to be followed by an applicant in order to obtain an RNP AR APCH authorization.

2. Purpose of the Job Aid

2.1 To give operators and inspectors information on the main RNP AR APCH reference documents.
2.2 To provide tables showing the contents of the application, the associated reference paragraphs, the place in the application of the operator where RNP AR APCH elements are mentioned and columns for inspector comments and follow-up on the status of various elements of RNP AR APCH.

3. Recommended inspector and operator actions

Some recommendations for use of the Job Aid follow:

3.1 At the pre-application meeting with the operator, the inspector reviews the “basic events of the RNP AR APCH approval process” described in Part 1 of this Job Aid, in order to provide an overview of the approval process events.
3.2 The inspector reviews this Job Aid with the operator in order to establish the form and content of the RNP AR APCH approval application.
3.3 The operator uses this Job Aid as a guide to collect the documents/RNP AR APCH Job Aids of the RNP AR APCH application.
3.4 The operator inserts in the Job Aid references showing in what part of its documents are the RNP AR APCH programme elements located.
3.5 The operator submits the Job Aid and the application to the inspector (documents/RNP AR APCH Job Aides).
3.6 The inspector indicates in the Job Aid whether an item is in compliance or needs corrective action.
3.7 The inspector informs the operator as soon as possible when a corrective action by the operator is required.
3.8 The operator provides the inspector with the revised material when so requested.
3.9 The CAA provides the operator with the operational specifications (OpSpecs) or a letter of authorisation (LOA), as applicable, when the tasks and documents have been completed.

4. Structure of the Job Aid

5. Main Sources of Documents, Information, and Contacts

Advisory Circular CA 91-009 - Approval of aircraft and operators for RNP approach procedures with authorisation required (RNP AR APCH) operations, is available on the ICAO/SAM Regional Office web page (www.lima.icao.int) through the SRVSOP link.

6. Main Reference Documents

Reference documents	Titles
Annex 6	Operation of aircraft
ICAO Doc 9613	Performance-based navigation (PBN) manual
FAA AC 90-101	Approval guidance for RNP procedures with SAAAR
EASA AMC 20-26	Airworthiness approval and operational criteria for RNP authorization required (RNP AR) operations
FAA AC 20-130A	Airworthiness approval of navigation or flight management systems integrating multiple navigation sensors
FAA AC 20-138A	Airworthiness approval of Global navigation satellite system (GNSS) equipment
TSO-C115b	Airborne area navigation equipment using multi-sensor inputs
TSO-C129a	Airborne supplemental navigation equipment using the global positioning system (GPS)
TSO-C145a	Airborne navigation sensors using the global positioning system (GPS) augmented by the wide area augmentation system (WAAS)
TSO-C146a	Stand-Alone airborne navigation equipment using the global positioning system (GPS) augmented by the wide area augmentation system (WAAS)

PART 1: GENERAL INFORMATION

Basic events in RNP AR APCH approval process

	Action by the operator	Action by the CAA
1	Establishes the need to obtain the RNP AR APCH authorization.	
2	Reviews the AFM, AFM supplement or Type Certificate Data Sheet (TCDS), or other appropriate documents (*e.g.,* service bulletins (SB), service letters (SL), etc.) to determine the eligibility of the aircraft for RNP AR APCH operations. The operator contacts the aircraft or avionics manufacturer, if necessary, to confirm RNP AR APCH aircraft eligibility or better.	
3	Contacts the CAA to schedule a pre-application meeting to discuss the operational approval requirements.	
4		During the pre-application meeting, establishes: • the form and contents of the application; • the documents that support RNP AR APCH approval • the date in which the application will be submitted for evaluation • if necessary, conducts a validation flight observed by the CAA
5	Submits the application at least 60 days before start-up of RNP AR APCH operations.	
6		Reviews the request of the operator
7	Once the amendments to manuals, programmes, and documents have been approved or accepted, provides training to flight crews, flight dispatchers, and maintenance personnel, and conducts a validation flight, if required by the CAA.	Only if required, participates in the validation flight.
8		Once the operational and airworthiness requirements have been met, issues the operational approval in the form of OpSpecs for LAR 121 or 135 or equivalent operators, or a LOA for LAR 91 or equivalent operators, as appropriate.

Notes related to the approval process

1. **Responsible authority**

   a. **Commercial air transport (LAR 121 and/or 135 or equivalent regulations).-** The **State of registry** determines that the aircraft meets the airworthiness requirements. The **State of the operator** issues the RNP AR APCH approval (*e.g.,* OpSpecs).

   b. **General Aviation (LAR 91 or equivalent).-** The **State of Registry** determines that the aircraft meets airworthiness requirements and issues the operational approval (*e.g.,* an L regulation).

2. The CAA does not need to issue an LOA or equivalent document for each individual area of operation in the case of LAR 91 operators.

3. LAR 121 and/or 135 operators with RNP AR APCH approval must list this approval in the OpSpecs.

4. Related sections of the Latin American Aeronautical Regulations (LAR) or equivalent regulations

   a. LAR 91 Sections 91.1015 and 91.1640 or equivalents

   b. LAR 121 Section 121.995 (b) or equivalent

   c. LAR 135 Section 135.565 (c) or equivalent

5. Related ICAO documents

   a. Annex 6 to the Convention on International Civil Aviation – Operation of aircraft

   b. Annex 10 to the Convention on International Civil Aviation – Aeronautical telecommunications

   c. Annex 15 to the Convention on International Civil Aviation – Aeronautical information services

   d. ICAO Doc 9613 – Performance-based navigation (PBN) manual

   e. ICAO Doc 9905 - Required navigation performance authorization required (RNP AR) procedure design manual (final draft)

   f. ICAO Doc 4444 – Procedures for air navigation services – Air traffic management

PART 2: INFORMATION ON THE IDENTIFICATION OF AIRCRAFT AND OPERATORS

NAME OF THE OPERATOR: ____

Aircraft manufacturer, model, and series	Registration numbers	Serial numbers	RNP AR APCH system Number, manufacturer, and model	RNP specification

DATE OF PRE-APPLICATION MEETING ____

DATE ON WHICH THE APPLICATION WAS RECEIVED ____

DATE ON WHICH THE OPERATOR INTENDS TO BEGIN RNP AR APCH OPERATIONS ______________________

IS THE CAA NOTIFICATION DATE APPROPRIATE? YES _____ NO _____

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PART 3 – OPERATOR APPLICATION (ANNEXES AND DOCUMENTS)

Annex	Title of annex/document	Indication of inclusion by the operator	Comments by the Inspector
A	**Operator letter requesting RNP AR APCH authorization**		
B	**Airworthiness documents showing aircraft eligibility for RNP AR APCH.** AFM, AFM revision, AFM supplement, or Type certificate data sheet (TCDS) showing that the RNP navigation system is eligible for RNP AR APCH. Documentation produced by the manufacturer.- Aircraft that have documentation by the manufacturer documenting compliance with SRVSOP CA 91-009 criteria or equivalent documents, meet the performance and functional requirements of said document.		
C	**Aircraft modified to meet RNP AR APCH standards. Documentation on aircraft inspection and/or modification, if applicable.** Maintenance records documenting the installation or modification of aircraft systems (*e.g.,* FAA Form 337 – major repairs and alterations).		
D	**Maintenance programme** • For aircraft with established maintenance procedures for RNP AR APCH systems, the list of references of the document or programme. • For recently installed RNP AR APCH systems, the maintenance procedures for their review.		
E	**Minimum equipment list (MEL) (only for operators conducting operations based on a MEL):** MEL showing provisions for RNP AR APCH systems.		

Annex	Title of annex/document	Indication of inclusion by the operator	Comments by the Inspector
F	**Training** **1. LAR 91 operators or equivalent: Training methods:** Training at home, LAR 142 training centres, or other training courses, course completion records. **2. LAR 121 and/or 135 operators or equivalents:** Training programmes (training curricula) for flight crews, flight dispatchers, and maintenance personnel.		
G	**Operating policies and procedures** **1. LAR 91 operators or equivalents:** Operations manual (OM) or sections to be attached to the application, corresponding to RNP AR APCH operating procedures and policies. **2. LAR 121 and/or 135 operators or equivalents:** Operations manual and checklists.		
H	**Navigation database** Details of the navigation data validation programme		
I	**Withdrawal of RNP AR APCH approval** Indication of the need to follow up on navigation error reports submitted and the possibility of withdrawal of RNP AR APCH approval.		
J	**Validation flight plan** Plan showing that the operator is capable of conducting the requested operations.		
K	**RNP AR APCH approach monitoring programme** Programme to collect data on the RNP AR APCH procedures to be conducted		

CONTENTS OF THE APPLICATION TO BE SUBMITTED BY THE OPERATOR

____ **DOCUMENTATION SHOWING RNP AR APCH COMPLIANCE OF THE AIRCRAFT/NAVIGATION SYSTEMS**

____ **OPERATING PROCEDURES AND POLICIES**

____ **SECTIONS OF THE MAINTENANCE MANUAL RELATED TO THE RNP AR APCH SYSTEM (if not previously reviewed)**

Note 1: Documents may be grouped in a single folder or may be sent as individual documents.

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PART 4: CONTENTS OF THE OPERATOR APPLICATION FOR RNP AR APCH OPERATIONS

#	Contents of the RNP AR APCH application by the operator	Reference paragraphs CA 91-009	In what Annexes/Documents of the operator can the application contents be located	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
1	**Operator request letter** Statement of intent to obtain RNP AR APCH authorization.	Appendix 7, Paragraph b) 1)	Annex A		
2	**Type of aircraft and description of aircraft equipment** A configuration list which detail the relevant components and the equipment to be used in the operation. The list shall include each manufacturer, model and version of the equipment and software of the installed FMS.	Appendix 7, Paragraph b) 3)			
3	**Aircraft qualification documentation** Documentation showing that the equipment of the proposed aircraft meets the requirements of Appendix 2 to CA 91-009 or equivalent documents (*e.g.*, FAA AC 90-101 Appendix 2). This documentation shall contain any requirements in terms of hardware, software, procedures, and limitations.	Appendix 7, Paragraph b) 2)	Annex B Annex C		
4	**Training programmes** a) **LAR 121 or 135 operators or equivalents: Training programmes:** Operators will develop an initial and periodic training programme for flight crews, flight dispatchers, if applicable and maintenance personnel. b) **LAR 91 operators or equivalent: Training methods:** The following methods are acceptable for these	Appendix 7, Paragraph b) 6)	Annex F		

#	Contents of the RNP AR APCH application by the operator	Reference paragraphs CA 91-009	In what Annexes/Documents of the operator can the application contents be located	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
	operators: Training at home, LAR 142 training centres, or other training courses**.**				
5	**Operations manual (OM) and checklists** a) **LAR 121 and/or 135 operators or equivalents:** Operations manual and checklists. b) **LAR 91 operators or equivalents:** Operations manual or section of the operator application documenting RNP AR APCH policies and procedures.	Appendix 7, Paragraph b) 10)			
6	**Maintenance procedures** • For aircraft with established maintenance practices for RNP AR APCH navigation systems, the operator will provide document references. • For newly installed RNP AR APCH systems, the operator will provide maintenance practices for review.	Appendix 7, Paragraph b) 11)	Annex D		
7	**Minimum equipment list (MEL)** The operator will revise the MEL in order to incorporate the aspects necessary to conduct RNP AR APCH operations.	Appendix 7, Paragraph b) 13)	Annex E		
8	**Navigation data validation programme** The operator will provide details of the navigation data validation programme.	Appendix 7, Paragraph b) 5)	Annex F		

#	Contents of the RNP AR APCH application by the operator	Reference paragraphs CA 91-009	In what Annexes/Documents of the operator can the application contents be located	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
9	**RNP AR APCH monitoring programme** The operator will establish a monitoring programme that will collect data on the performed RNP AR APCH procedures. Each operation must be recorded, and unsatisfactory attempts must include the factors that prevented successful completion of an operation.	Appendix 7, Paragraph b) 12)	Annex H		
10	**Validation test plan** The operator will develop a validation test plan to show that it is capable of conducting the proposed operation. The plan will include, at least, the following: a) a statement that the validation plan has been designed to show the capability of the aircraft to carry out RNP AR APCH procedures; b) the operating and dispatch procedures of the operator; and c) MEL procedures.	Appendix 7, Paragraph b) 14)	Annex I		
11	**Flight operational safety assessment (FOSA)** The operator will establish a methodology for the analysis and quantitative and qualitative assessment of navigation systems, aircraft systems, operational procedures, hazards, failure mitigation, normal conditions, abnormal conditions, and operational environment related to safety.	Appendix 7, Paragraph b) 16)			

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PART 5 – GUIDE FOR DETERMINING RNP AR APCH AIRCRAFT ELIGIBILITY

#	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
1	**Aircraft eligibility**	Paragraph 9.2	Annex B		
	a) **For new aircraft.-** the aircraft qualification documentation can be approved by the CAA as part of an aircraft certification project, and will be reflected in the AFM and related documents.	Paragraph 9.2 a)			
	b) **For aircraft in use.-** Documentation produced by the manufacturer.	Paragraph 9.2 b)	Annex B		
	c) **Aircraft modified to meet RNP AR APCH standards.-** Aircraft inspection and/or modification documentation, if applicable. Maintenance records documenting the installation or modification of aircraft systems (*e.g.*, FAA Form 337 – major repairs and alterations).	Paragraph 9.3	Annex B		
2	**Aircraft qualification**	Appendix 2			
	a) **Previously certified aircraft.-** Operators of previously certified aircraft can document compliance with CA 91-009 (RNP AR APCH) or equivalent documents, without a new airworthiness project (*e.g.*, without making a change in the AFM) and will notify the CAA of any new performance not covered by the original airworthiness approval.	Appendix 2 Paragraph 1. c)			

#	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
	b) The AFM or other aircraft qualification evidence shall indicate the normal and abnormal flight crew procedures, failure alerting responses, and any other limitation, including information related to the operating modes required for flying an RNP AR APCH procedure.	Appendix 2 Paragraph 1. d)			
	c) In addition to the specific RNP AR APCH guide presented in CA 91-009 or equivalent documents (*e.g.*, EASA AMC 20-26 or FAA AC 90-101), the aircraft must comply with AC 20-129 and either AC 20-130 () or AC 20-138 ().	Appendix 2 Paragraph 1. e)			
3	**Navigation sensors.-** On the horizontal plane, the RNP equipment will use data input from the following types of position sensors, but with the GNSS as primary positioning basis: a) Global navigation satellite system (GNSS). b) Inertial navigation system (INS) or inertial reference system (IRS), with automatic position updating from suitable radio-based navigation equipment. c) Distance-measuring equipment (DME) when the RNP AR APCH procedure authorizes it.	Paragraph 6.1 b)			
	Global positioning system (GPS) a) The sensor must meet the FAA AC 20-138 () criteria. For systems that comply with this	Appendix 2 Paragraph 3. a) 1)			

#	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
	AC, the following sensor precisions can be used for analysing total system precision without any additional justification: 1) precision of the GPS sensor better than 36 m (95%); and 2) precision of the augmented GPS sensor (with GBAS or SBAS) better than 2 m (95%).				
	Inertial reference system (IRS).- An IRS must meet the criteria of Appendix G LAR 121 or Appendix G Part 121 of United States 14 CFR or equivalents. Aircraft manufacturers and applicants can demonstrate improved inertial performance according to the methods described in Appendix 1 or 2 of FAA Order 8400.12A.	Appendix 2 Paragraph 3. a) 2)			
	Distance measuring equipment (DME).- Initiation of all RNP AR APCH procedures is based on GNSS updating. Except where the use of DME in a procedure is specifically designated as “not authorized”, DME/DME updating can be used as a reversal mode during the approach and missed approach when the system complies with the navigation precision. The manufacturer and the operator shall identify any DME infrastructure or procedure limitation preventing an aircraft type from meeting this requirement	Appendix 2 Paragraph 3. a) 3)			
	VHF omnidirectional radio range (VOR).- For initial RNP AR APCH implementation, the RNP system may not use VOR updating. The	Appendix 2			

#	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
	manufacturer and the operator shall identify any constraints on the VOR infrastructure or the procedure for a given aircraft to comply with this requirement.	Paragraph 3. a) 4)			
	Multi-sensor systems.- For multi-sensor systems, there must be automatic reversal to an alternate RNAV sensor if the primary RNAV sensor fails. Automatic reversal from a multi-sensor system to another multi-sensor system is not required.	Appendix 2 Paragraph 3. a) 5)			
	Altimetry system error.- 99.7% of the altimetry system error for each aircraft (assuming the temperature and adiabatic lapse rate of standard atmosphere) must be smaller than, or equal to, the following, with the aircraft in approach configuration: $\mathbf{ASE} = -8.8 \cdot 10^{-8} \cdot \mathbf{H}^2 + 6.5 \cdot 10^{-3} \cdot \mathbf{H} + 50$ where H is the aircraft true altitude	Appendix 2 Paragraph 3. a) 6)			
	Temperature compensation systems.- Systems that provide temperature-based correction for the VNAV barometric guide must comply with Appendix H.2 to document RTCA/DO-236. This applies to the final approach segment. Compliance with this requirement must be documented to allow the operator to conduct RNP AR APCH approaches when the real temperature is above or below the design limit of the published procedure. Appendix H.2 also	Appendix 2 Paragraph 3. a) 7)			

#	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
	provides guidance on the operational aspects related to temperature compensation systems, such as the interception of compensated paths from non-compensated procedure altitudes.				
4	**Performance and functional requirements of RNP AR APCH systems**	Appendix 2	Annex B		
5	**Navigation database** Details of the navigation data validation programme.	Appendix 3	Annex B		

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PART 6 - BASIC PILOT PROCEDURES FOR RNP AR APCH OPERATIONS

	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	Operating procedures	Appendix 4	Annex G		
1	**Pre-flight considerations**	Appendix 4 Paragraph 2			
	Minimum equipment list (MEL).- The operator MEL must be developed or revised to indicate equipment requirements for instrument RNP AR APCH procedures. Guidance on these equipment requirements is available in the documents of the aircraft manufacturer. The required equipment may depend on the intended navigation precision and whether the missed approach requires an RNP value of less than 1.0. For example, GNSS and AP are normally required for a low navigation precision. Normally, dual equipment is required for approaches when using a line of minima of less than RNP 0.3 and/or when the missed approach has an RNP value of less than 1.0. An operable enhanced ground proximity warning system (EGPWS/TAWS) is required for all RNP AR APCH procedures. It is advisable that the EGPWS/TAWS use local pressure- and temperature-compensated altitudes (*e.g.,* a corrected GNSS and barometric altitude) and that it includes data on significant obstacles and terrain. The flight crew must be aware of the equipment requirement.	Appendix 4 Paragraph 2 a)			
	Autopilot (AP) and flight director (FD).- For procedures with a navigation precision of less than RNP 0.3 or with RF legs, the use of AP and FD driven by the aircraft RNP system is required in all cases. Therefore, the AP and FD must operate with a suitable precision to track the lateral and vertical paths required by a	Appendix 4 Paragraph 2 b)			

Topics		Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	specific RNP AR APCH procedure. When the dispatch or release of a flight is predicated on flying an RNP AR APCH approach that requires the use of AP at the destination and/or alternate aerodrome, the flight dispatcher or pilot in command must make sure that the AP is installed and operational.				
	Assessment of an RNP AR APCH dispatch or release.- The operator must have a predictive performance capability to forecast whether the specific RNP will be available at the location and time of a desired RNP AR APCH operation. This capability can be provided through a ground service and does not need to reside in the aircraft avionic equipment. The operator must establish procedures requiring the use of this capability as a dispatch or release tool and as a flight-tracking tool in case of reported failures. RNP assessment must consider the specific combination of aircraft capabilities (sensors and integration). a) **Assessment of RNP AR APCH with GNSS updating**.- The predictive capability must take into account known and predicted temporary suspension of GNSS satellite service or other negative effects on navigation system sensors. The prediction program shall not use a masking angle of less than 5º, as operational experience indicates that satellite signals at low elevations are not reliable. The prediction must use the current GPS constellation with an algorithm identical to that used in the on-board equipment. For RNP AR APCH procedures in high terrain, the operator must use a masking angle appropriate to the terrain. b) From the initiation of the approach, RNP AR APCH procedures require GNSS updating.	Appendix 4 Paragraph 2 c)			

	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	NAVAID exclusion.- The operator must establish procedures to exclude air navigation facilities in accordance with published NOTAMs (*e.g.,* DMEs, VORs, and localizers). Rationality checks of the internal avionic equipment may not be appropriate for RNP AR APCH operations.	Appendix 4 Paragraph 2 d)			
	Validity of the navigation database.- Upon initiating the system, the pilots of aircraft equipped with certified RNP systems must confirm that the navigation database is valid. The databases are expected to be current for the duration of the flight. If the AIRAC cycle changes during the flight, the operators and pilots must establish procedures to ensure the precision of navigation data, including the suitability of navigation facilities used for defining routes and flight procedures. Traditionally, this has been accomplished by verifying electronic data against paper documents. One acceptable means is to compare aeronautical charts (new and old) to verify navigation fixes prior to flight dispatch or release. If an amended chart has been published for the procedure, the navigation database must not be used to conduct the operation.	Appendix 4 Paragraph 2 e)			
2	**In-flight considerations**	Appendix 4 Paragraph 3			
	Flight plan modification.- Pilots are not authorized to fly a published RNP AR APCH procedure unless it can be retrieved by its name from the navigation database and conforms to the published procedure. The lateral path must not be modified, except that the pilot may accept a clearance to fly direct to a fix located prior the FAF in the approach procedure, and that does not immediately precede an RF leg. The only other acceptable	Appendix 4 Paragraph 3. a)			

	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	modification to the loaded procedure is to change speed and/or altitude waypoint constraints on the initial, intermediate, or missed approach segments (for example, corrections applied due to cold temperature or to comply with an ATC clearance/instruction).				
	Required equipment list.- The flight crew must have a list of the equipment required to conduct RNP AR APCH procedures or alternate methods for addressing, during the flight, equipment failures that hinder the execution of an RNP AR APCH procedure (*e.g.,* the quick reference handbook - QRH)	Appendix 4 Paragraph 3. b)			
	RNP AR APCH management.- Flight crew operating procedures must ensure that the navigation system uses the appropriate navigation precision during the approach. If the approach chart shows several minima associated to different navigation precision values, the flight crew must confirm that the desired navigation precision has been entered in the RNP system. If the RNP system does not extract and set the navigation precision from the on-board database for each leg of the procedure, then the flight crew operating procedures must ensure that the lowest navigation precision required completing the approach or missed approach has been selected before starting the approach.	Appendix 4 Paragraph 3. c)			
	GNSS updating.- From the beginning of the approach, all instrument RNP AR APCH procedures require GNSS updating of the navigation position solution. The flight crew must verify that GNSS updating is available before starting the RNP AR APCH procedure. If at any time during the approach GNSS updating is lost and the navigation system does not have the performance to continue the approach, the flight crew must abandon the RNP AR APCH procedure, unless the pilot has in sight the visual	Appendix 4 Paragraph 3 d)			

	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	references required to continue such approach.				
	Radio updating.- The initiation of any RNP AR APCH procedure is based on GNSS updating. Except where specifically designated in a procedure as not authorized, DME/DME updating can be used as a reversal mode during the approach or missed approach when the system complies with the navigation precision. VOR updating is not authorized at this time. Consequently, the flight crew must follow operator procedures to inhibit specific facilities (see paragraph 2.d) of this appendix).	Appendix 4 Paragraph 3 e)			
	Approach procedure confirmation.- The flight crew must confirm that the correct procedure has been selected. This procedure includes the confirmation of waypoint sequence, the rationality of track angles and distances, and any other parameter that can be modified by the pilot, such as altitude and speed constraints. A procedure must not be used if validity of the navigation database is in doubt. A navigation system text display or a navigation map display can be used.	Appendix 4 Paragraph 3 f)			
	Track deviation monitoring.- Pilots must use a lateral deviation indicator, an FD and/or an AP in lateral navigation mode during RNP AR APCH procedures. Pilots of aircraft with lateral deviation indicators must ensure that indicator scaling (full-scale deflection) is suitable for the navigation precision associated with the various segments of the RNP AR APCH procedure. All pilots are expected to maintain route centre lines, as depicted by on-board lateral deviation indicators and/or in the flight guidance, during all RNP operations, unless authorized to deviate by the ATC or under emergency conditions.	Appendix 4 Paragraph 3 g)			

	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	For normal operations, the cross-track error/deviation (the difference between the path estimated by the RNP system and the aircraft position relative to the path) shall be limited to ± ½ the navigation precision associated with the procedure segment. Small lateral deviations from this requirement (*e.g.,* overshooting or undershooting the limit) during or immediately after a turn are allowed, up to a maximum of 1 times (1xRNP) the navigation precision of the procedure segment. The vertical deviation must be within 75 ft during the final approach segment. Lateral deviations shall be monitored above and below the glide path (GP). While being above the glide path provides a margin over the obstacles during the final approach, it can result in the pilot deciding to do a go-around closer to the runway, which reduces obstacle clearance during the missed approach. Pilots must execute a missed approach if lateral deviation exceeds 1xRNP or if vertical deviation exceeds 75 ft, unless the pilot has in sight the visual references required to continue the approach. a) Some aircraft navigation displays do not incorporate lateral and vertical deviations scaled for each RNP AR APCH operation in the primary field of view of the pilot. When using a moving map, a low-resolution vertical deviation indicator (VDI), or a numeric deviation display, flight crew training and procedures must ensure the effectiveness of these displays. Normally, this implies a demonstration of the procedure with a number of trained crews and the inclusion of this monitoring procedure in the recurrent training program for RNP AR APCH.				

	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	b) For aircraft using a CDI for lateral path tracking, the AFM or the aircraft qualification guidance shall indicate which navigation precision (RNP value) and operations the aircraft supports and the effects of the operation on CDI scale. The flight crew must know the CDI full-scale deflection (FSD) value. The avionics system can automatically adjust the CDI scale (depending on the flight phase) or the flight crew can manually adjust such scale. If the flight crew manually selects the CDI scale, the operator must have procedures in place and provide training to ensure that the CDI scale selection is appropriate for the intended RNP AR APCH operation. The deviation limit must be readily visible, considering CDI scale (*e.g.,* full-scale deflection).				
	System cross-check.- For RNP AR APCH procedures with a navigation precision of less than 0.3, the flight crew must monitor the lateral and vertical guidance provided by the RNP navigation system to ensure that this guidance is consistent with other available data and displays provided by an independent means.	Appendix 4 Paragraph 3 h)			
	Procedures with RF legs.- An RNP AR APCH procedure may require aircraft to have the capability of executing an RF leg to avoid terrain and obstacles. Since not all aircraft have this capability, flight crews must know if they can or cannot carry out these procedures. When an RF leg is flown, it is essential for the flight crew to follow the flight path in order to maintain the intended track. a) If a go-around is initiated during or immediately after an RF leg, the flight crew must be aware of the importance of maintaining the published path as closely as possible. The	Appendix 4 Paragraph 3 i)			

	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	operator must develop and establish operating procedures for aircraft that do not remain in LNAV when initiating a go-around, in order to ensure that the intended track of the RNP AR APCH procedure is maintained. b) Pilots must not exceed the maximum speeds shown in Table 4-1 of Appendix 4 to SRVSOP CA 91-009 during the RF leg. For example, a Category C A320 must reduce its speed to 160 KIAS at the final approach fix (FAF) or can fly as fast as 185 KIAS if it uses Category D minima. A missed approach before the decision altitude (DA) may require a segment speed for that segment to be maintained.				
	Temperature compensation.- In aircraft that have temperature compensation capability according to paragraph 3.a)7) of Appendix 2 to SRVSOP CA 91-009, flight crews can do without temperature limits for RNP AR APCH procedures if the operator provides the flight crews with training on the use of this capability. Temperature compensation through the aircraft system is applicable to VNAV guidance and is no substitute for the low-temperature compensation to be applied by the flight crew at minimum altitudes or at the decision altitude. Flight crews must be familiar with temperature compensation effects when intercepting the compensated path described in document EUROCAE ED-75B/RTCA DO-236B Appendix H.	Appendix 4 Paragraph 3 j)			
	Altimeter setting.- Due to reduced obstacle clearance inherent to instrument RNP AR APCH procedures, the flight crew must verify that the current local altimeter is set prior to the FAF but not prior to the IAF. The execution of an instrument RNP AR APCH procedure requires that the current altimeter be set for the aerodrome of intended landing. Remote altimeter settings are not	Appendix 4 Paragraph 3 k)			

	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	allowed.				
	Altimeter cross-check.- Prior to the FAF, but not before the IAF, the flight crew must carry out a cross-check of both pilot altimeters to make sure they agree within ± 100 ft. If the cross-check fails, the crew must not continue with the approach. If the avionics system provides an automatic altitude comparison warning system for pilot altimeters, flight crew procedures shall indicate the action to be taken in the event of an altimeter comparator warning while executing an RNP AR APCH.	Appendix 4 Paragraph 3 l)			
	VNAV altitude transitions.- The aircraft VNAV barometric system provides fly-by vertical guidance to ensure a smooth transition when intercepting the glide path prior to the FAF. Small vertical shifts, which may occur in a vertical constraint (*e.g.,* in the FAF), are considered operationally acceptable and desirable since they allow for the capture of a new or the next vertical segment. This temporary deviation below the published minima is acceptable as long as the deviation is limited to no more than 100 ft and is the result of a normal VNAV capture. This applies to both “leveling” and “altitude capture” segments that follow a climb or descent or vertical climb or beginning of a segment with descent, or when climb and descent paths with different slopes come together.	Appendix 4 Paragraph 3 m)			
	Non-standard climb gradient.- When the operator intends to use a DA associated with a missed approach non-standard climb gradient, it must ensure that the aircraft will be able to comply with the climb gradient published for the expected weight (mass) of the aircraft, atmospheric conditions, and operating procedures before conducting the operation. When the operator has performance personnel available to determine whether its aircraft can meet the	Appendix 4 Paragraph 3 n)			

	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	published climb gradients, such personnel must provide information to pilots about the climb gradients that they must comply with.				
	Engine-out procedures.- Aircraft may demonstrate an acceptable flight technical error (FTE) with one engine inoperative when conducting RNP AR APCH procedures. Otherwise, flight crews are expected to take appropriate action in case of an engine failure during an approach, so no specific aircraft qualification is required in this case. The aircraft qualification must identify any performance limitation in case of engine failure to support the definition of the appropriate flight crew procedures. Operators must pay special attention to published procedures with non-standard climb gradients.	Appendix 4 Paragraph 3 o)			
	Missed approach or go-around a) **Missed approach procedure requiring RNP 1.0**.- Where possible, the missed approach will require RNP 1.0. The missed approach of these procedures is similar to the missed approach of an RNP APCH operation. b) **Missed approach procedures requiring RNP of less than 1.0**.- When necessary, RNP values of less than 1.0 will be used in the missed approach. For an operator to be approved to execute these approaches, the equipage and procedures must meet the criteria established in paragraph 6 of Appendix 2 (Requirements for missed approaches with an RNP of less than 1.0). c) In many aircraft, a change may occur in lateral navigation when TOGA is activated during a missed approach or go-around. Also, in many aircraft, TOGA activation disconnects	Appendix 4 Paragraph 3 p)			

	Topics	Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	the AP and FD from LNAV guidance, and the FD reverts to track-hold derived from the inertial system. LNAV guidance to the AP and FD shall be re-engaged as quickly as possible. d) Flight crew procedures and training programs must address the impact on navigation capability and flight guidance if the pilot initiates a go-around during a turn. In the event an early missed approach is initiated, the flight crew must follow the approach and missed approach tracks unless otherwise cleared by the ATC. The flight crew shall also be aware that RF legs are designated based on the maximum true speed at normal altitudes, and initiating an early missed approach will reduce the maneuverability margin, and will potentially make it impractical to hold the turn at missed approach speeds. e) Upon loss of GNSS updating, the RNP guidance may begin to navigate on IRU, if installed on the aircraft, but the aircraft will begin to drift, degrading the navigation position solution. Therefore, when RNP AR APCH missed approach operations are based on IRU autonomous navigation, the inertial guidance can only provide RNP guidance for a specific amount of time.				
	Contingency procedures a) **Failure while en route**.- The aircraft RNP capability is dependent upon operational equipment and GNSS satellites. Before initiating the approach, the flight crew must be capable of assessing the impact of equipment failure on the RNP AR APCH procedure and take the appropriate corrective action. As stated in paragraph 2.c) of	Appendix 4 Paragraph 3 q)			

Topics		Reference paragraphs CA 91-009	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector: Item status and date
	this appendix, the flight crew must also be capable of assessing the impact of changes in GNSS constellation and take appropriate corrective action. b) **Failure on approach**.- The operator contingency procedures must cover at least the following conditions: 1) RNP system components failures, including those affecting lateral and vertical deviation performance (*e.g.,* failures of GPS sensors, AP or FD). 2) Loss of navigation signal-in-space (loss or degradation of external signal).				

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Job Aid: RNP AR APCH
Version: Original
Date: 12/10/2009

APPENDIX G-1

ADVISORY CIRCULAR

AC	**:**	**91-010**
DATE	**:**	**12/10/09**
REVIEW	**:**	**1**
ISSUED BY	**:**	**SRVSOP**

SUBJECT: AIRCRAFT AND OPERATORS APPROVAL FOR APPROACH OPERATIONS WITH VERTICAL GUIDANCE/BAROMETRIC VERTICAL NAVIGATION (APV/baro-VNAV)

ADVISORY CIRCULAR

AC	**:**	**91-010**
DATE	**:**	**12/10/09**
REVIEW	**:**	**1**
ISSUED BY	**:**	**SRVSOP**

SUBJECT: AIRCRAFT AND OPERATORS APPROVAL FOR APPROACH OPERATIONS WITH VERTICAL GUIDANCE/BAROMETRIC VERTICAL NAVIGATION (APV/baro-VNAV)

1. PURPOSE

This advisory circular (AC) establishes APV/baro-VNAV approval requirements (barometric vertical navigation only) for aircraft and operators. Barometric vertical navigation may be included together with lateral navigation in a RNP APCH approach, as established in CA 91-008. Criteria of this AC together with criteria of AC 91-008, establish requirements for RNP APCH approach with baro-VNAV.

An operator may use alternative means of compliance, provided they are acceptable to the Civil Aviation Administration (CAA).

Use of the future tense of the verb or the term “must” applies to an applicant or operator that chooses to meet the criteria established in this AC.

2. RELATED SECTIONS OF THE LATIN AMERICAN AERONAUTICAL REGULATIONS (LARs) OR EQUIVALENT

LAR 91: Sections 91.1015 and 91.1640 or equivalents

LAR 121: Section 121.995 (b) or equivalent

LAR 135: Section 135.565 (c) or equivalent

3. RELATED DOCUMENTS

Annex 6	Operation of aircraft
Doc 9613	Performance-based navigation (PBN) manual
	Attachment A – Barometric VNAV
Doc 9905	Required navigation performance authorization required (RNP AR) procedure design manual (final draft)
Doc 8168	Aircraft operations
	Volume I: Flight procedures
	Part II, Section 4, Chapter 1 – APV/baro-VNAV approach procedures
	Volume II: Construction of visual and instrument flight procedures
	Part III, Section 3, Chapter 4 – APV/baro-VNAV
AMC 20-27	Airworthiness approval and operational criteria for RNP APPROACH (RNP APCH) operations including APV BARO-VNAV operations
FAA AC 90-105	Approval guidance for RNP operations and barometric vertical navigation in the U.S. National Airspace System – Appendix 4 – Use of barometric VNAV

4. DEFINITIONS AND ABBREVIATIONS

4.1 Definitions

a) **Approach procedure with vertical guidance (APV).-** An instrument approach procedure which utilizes lateral and vertical guidance but does not meet the requirements established for precision approach and landing operations.

b) **Barometric vertical navigation (baro-VNAV).-** Is a navigation system that presents to the pilot computed vertical guidance referenced to a specified vertical path angle (VPA), nominally 3°. The computer-resolved vertical guidance is based on barometric altitude and is specified as a VPA from reference datum height (RDH).

c) **Decision altitude (DA) or decision height (DH).-** A specified altitude or height in the precision approach or approach with vertical guidance at which a missed approach must be initiated if the required visual reference to continue the approach has not been established.

Note 1.- *The decision altitude (DA) is referenced to mean sea level and the decision height (DH) is referenced to the threshold elevation.*

Note 2.- *The required visual reference means that section of the visual aids or of the approach area which should have been in view for sufficient time for the pilot to have made an assessment of the aircraft position and rate of change of position, in relation to the desired flight path. In Category III operations with a decision height the required visual reference is that specified for the particular procedure and operation.*

Note 3.- *For convenience where both expressions are used they may be written in the form "decision altitude/height" and abbreviated "DA/H".*

d) **Flight management system (FMS).-** Integrated system made up by an on-board sensor, a receiver, and a computer with navigation and aircraft performance databases, capable of providing performance values and RNAV guidance to a display and automatic flight control system.

e) **Initial approach fix (IAF).-** Fix that marks the beginning of the initial segment and the end of the arrival segment, if applicable. In RNAV application, this fix is normally defined as a “fly-by wayponit”.

f) **Non-precision approach (NPA) procedure.-** An instrument approach procedure which utilizes lateral guidance but does not utilize vertical guidance.

g) **Precision approach (PA) procedure.-** An instrument approach procedure using precision lateral and vertical guidance with minima as determined by the category of operation.

Note.- *Lateral and vertical guidance refers to the guidance provided either by:*

- a ground-based navigation aid; or
- computer-generated navigation data.

h) **Primary field of view.-** For purposes of this AC, the primary field of view is within 15 degrees of the primary line of sight of the pilot.

i) **Reference datum height (RDH).-** The height of the extended glide path or a nominal vertical path at the runway threshold.

j) **RNAV system**.- Area navigation system that allows the aircraft to operate on any desired flight path within the coverage of ground or airspace-based navigation aids or within the limits of the capability of self-contained navigation aids or a combination of both. An RNAV system may be included as part of a flight management system (FMS).

k) **RNP system**.- Area navigation system which supports on-board performance monitoring and alerting.

l) **Vertical navigation**.- A navigation method that allows the aircraft to operate on a vertical flight profile using altimetry sources, external flight path references, or a combination of these.

m) **Vertical path angle (VPA).-** Angle of the published final approach descent in baro-VNAV procedures.

n) **Waypoint (WPT).** A specified geographical location used to define an area navigation route or the flight path of an aircraft employing area navigation. Way-points are identified as either:

Fly-by waypoint (fly-by WPT).- A waypoint which requires turn anticipation to allow tangential interception of the next segment of a route or procedure, or

Flyover waypoint (flyover WPT).- A waypoint at which a turn is initiated in order to join the next segment of a route or procedure.

4.2 Abbreviations

a)	AAC	Civil Aviation Administration
b)	AC	Advisory circular (FAA)
c)	AFM	Airplane flight manual
d)	AIM	Aeronautical information manual
e)	AMC	Acceptable means of compliance
f)	AP	Autopilot
g)	APCH	Approach
h)	APV	Approach procedure with vertical guidance
i)	APV/baro-VNAV	Approach procedure with vertical guidance/Barometric vertical navigation
j)	AR	Authorization required
k)	ARINC	Aeronautical radio, Incorporated
l)	ASE	Altimetry system error
m)	ATC	Air traffic control
n)	baro-VNAV	Barometric vertical navigation
o)	CA/AC	Advisory circular (SRVSOP)
p)	CFIT	Controlled flight into terrain
q)	CFR	US Code of Federal Regulations
r)	CS	Certification specifications (EASA)
s)	DA/H	Decision altitude/height
t)	DME	Distance measuring equipment
u)	EASA	European Aviation Safety Agency
v)	EHSI	Enhanced horizontal situation indicator
w)	FAA	US Federal Aviation Administration
x)	FAF	Final approach fix
y)	FAP	Final approach point
z)	FD	Flight director

aa)	FMS	Flight management system
bb)	FTD	Flight training devices
cc)	FTE	Flight technical error
dd)	GNSS	Global navigation satellite system
ee)	Hg	Inches of mercury
ff)	hPa	Hectopascals
gg)	HSI	Horizontal situation indicator
hh)	IAF	Initial approach fix
ii)	IRU	Inertial reference unit
jj)	ISA	International standard atmosphere
kk)	KIAS	Indicated airspeed
ll)	LAR	Latin American Aeronautical Regulations
mm)	LNAV	Lateral navigation
nn)	LNAV FAF	final approach fix for lateral navigation
oo)	LNAV MDA	Lateral navigation minimum descent altitude
pp)	LOA	Letter of authorization/acceptance
qq)	MAPt	Missed approach point
rr)	MAPt LNAV	Missed approach point for lateral navigation
ss)	MDA/MDH	Minimum descent altitude/height
tt)	MEL	Minimum equipment list
uu)	NPA	Non-precision approach
vv)	ICAO	International Civil Aviation Organization
ww)	OCA/H	Obstacle clearance altitude/height
xx)	OM	Operations Manual
yy)	PANS-OPS	Procedures for air navigation services - Aircraft operations
zz)	PBN	Performance-base navigation
aaa)	PA	Precision approach
bbb)	PDE	Path definition error
ccc)	PF	Pilot flying
ddd)	PM	Pilot monitoring
eee)	PNF	Pilot not flying
fff)	QNE	Standard atmosphere that corresponds to 1013 hPa or 29.92” Hg. This setting indicates the altitude above the isobaric surface of 1013 hPa, if temperature is standard
ggg)	QNH	Pressure at mean sea level. This setting indicates the altitude above the means sea level (MSL), if temperature is standard.

hhh)	RDH	Reference datum height
iii)	RNAV	Area navigation
jjj)	RNP	Required navigation performance
kkk)	RNP APCH	Required navigation performance approach
lll)	RNP AR APCH	Required navigation performance approach with authorization required
mmm)	SBAS	Satellite-based augmentation system
nnn)	TCH	Obstacle clearance height
ooo)	TSO	Standard technical order
ppp)	VDI	Vertical deviation indicator
qqq)	VNAV	Vertical navigation
rrr)	VNAV DA	Vertical navigation decision altitude
sss)	VPA	Vertical path angle
ttt)	WPT	Waypoint

5. INTRODUCTION

5.1 The acceptable means of compliance of this AC are based on the use of barometric vertical navigation (baro-VNAV).

5.2 The baro-VNAV navigation system presents the pilot with estimated vertical guidance referenced to a specified vertical path angle (VPA), nominally of 3º. The computed vertical guide is based on the barometric altitude and is specified as a VPA from the reference datum height (RDH).

5.3 The calculated vertical path is stored in the instrument flight procedure specification in the database of the area navigation (RNAV) system or of the required navigation performance (RNP) system.

5.4 For other flight phases, barometric VNAV offers vertical guidance path information that can be defined by vertical angles or altitudes at the procedure fixes.

5.5 It should be noted that there is no vertical requirement in this AC associated with the use of vertical guidance outside of the final approach segment. Therefore, vertical navigation can be performed without VNAV guidance in the initial and intermediate segments of an instrument procedure.

5.6 Aircraft authorised to conduct RNP authorization required approach (RNP AR APCH) operations are considered eligible for the baro-VNAV operations described in this AC. In this sense, there is no need for a new approval according to the criteria established in this document.

5.7 The procedures to be established pursuant to this AC will permit the use of high-quality vertical navigation capabilities that will improve safety and reduce the risks of controlled flight into terrain (CFIT).

5.8 The material described in this AC has been developed based on the following documents:

- ✓ ICAO Doc 9613, Volume II, Attachment A – Barometric VNAV; and
- ✓ ICAO Doc 8168, Volume I, Part II, Section 4, Chapter 1 – APV/baro-VNAV approach procedures.

5.9 Where possible, this AC has been harmonised with the following guidance documents:

- ✓ EASA AMC 20-27 - Airworthiness approval and operational criteria for RNP APPROACH (RNP APCH) operations including APV BARO-VNAV operations; and

- ✓ FAA AC 90-105 Approval guidance for RNP operations and barometric vertical navigation in the U.S. national airspace system - Appendix 4 – Use of barometric VNAV.

Note.- *Notwithstanding harmonisation efforts, operators shall note the differences that exist between this AC and the aforementioned documents when applying for an authorization from the corresponding Administrations.*

6. GENERAL CONSIDERATIONS

6.1 Navaid infraestructure

The procedure design does not have unique infraestructure requirements. This criteria is based upon the use of barometric altimetry by an airborne RNAV/RNP system whose performance capability supports the required operation. The procedure design will have to take into account the functional capabilities required by this document.

6.2 Publications

Charting must follow the standards of Annex 4 for the designation of an RNAV procedure where the vertical flight path is specific by a glide path angle. The charting designation will remain consistent with the current convention (for example if the lateral procedures are predicated on GNSS, the charting will indicate RNAV $_{(GNSS)}$).

6.3 Air traffic control (ATC) coordination

It is expected that ATC will be familiar with aircraft VNAV capability, as well as issues associated with altimeter setting and temperature data required by the aircraft.

7. APV/baro-VNAV APPROACH PROCEDURES CLASSIFICATION

7.1 Approach procedures with vertical guidance/barometric vertical navigation (APV/baro-VNAV) are classified as instrument approach procedures for approach and landing operations with vertical guidance (see the definition in Annex 6, Part I, to the Chicago Convention). These procedures are published with a decision altitude/height (DA/H) and must not be confused with non-precision approach procedures (NPA), which specify a minimum descent altitude/height (MDA/H) below which the aircraft must not descend.

7.2 The use of APV/baro-VNAV procedures improves the safety of NPA procedures, providing a guided and stabilized descent for landing, thus avoiding an early descent to minimum altitudes.

7.3 Notwithstanding the above, the inherent inaccuracy of barometric altimeters and the certified performance of the specific RNAV/RNP mode used, prevent the systems of these procedures from emulating the accuracy of the systems used in a precision approach (PA). In particular, with some systems it might not be possible to keep the aircraft within the obstacle-free surfaces of Annex 14 to the Chicago Convention. Thus, the pilot must keep this possibility in mind when making the decision to land at the decision altitude/height (DA/H).

7.4 In APV/baro-VNAV approach procedures no final approach fix (FAF) or missed approach fix (MAPt) is identified.

7.5 The lateral part of APV/baro-VNAV criteria is based on non-precision RNAV criteria. However, the FAF is not part of the APV/baro-VNAV procedure and is replaced by a final approach point (FAP), although the RNAV FAF may be used as a final approach course fix in database design. Likewise, the MAPt is replaced by a DA/H, which depends upon the category of the aircraft.

7.6 The LNAV FAF and MAPt are used for coding purposes in the baro-VNAV procedure and are not aimed at inhibiting the descent in the FAP or restricting the DA/H.

7.7 The minimum DH for APV/baro-VNAV is 75 m (246 ft) plus the height loss margin. However, the operator may increase this minimum DH limit to at least 90 m (295 ft) plus a height loss margin, when the lateral navigation system is not certified to ensure that the aircraft will be within the inner approach, inner transitional, and balked landing surfaces indicated in Annex 14 to the Chicago Convention (extended as necessary above the inner horizontal surface to the obstacle clearance altitude/height (OCA/H)) with a high degree of probability.

8. NAVIGATION SYSTEM DESCRIPTION

8.1 Vertical navigation (VNAV)

a) In VNAV, the system allows the aircraft to fly level and descent point to point in a vertical linear profile path that is kept in an on board navigation database. The vertical profile will be based upon altitude constraints or VPAs, where appropriate, associated with the lateral navigation (LNAV) path waypoints (WPT).

***Note.-** Normally, VNAV is a flight guidance systems mode, where the RNAV/RNP equipment containing the VNAV capability provides path steering commands to the flight guidance system, which controls the flight technical error (FTE) by means of the pilot manual control in the vertical deviation display or through flight director (FD) or autopilot (AP) coupling.*

9. AIRWORTHINESS AND OPERATIONAL APPROVAL

9.1 In order to get an APV/baro-VNAV authorization, a commercial air transport operator shall obtain two types of approval:

a) an airworthiness approval from the State of registry; (see Article 31 of the Chicago Convention and Paragraphs 5.2.3 and 8.1.1 of Annex 6, Part I); and

b) the operational approval from the State of the operator (see Paragraph 4.2.1 and Attachment F to Annex 6, Part I).

9.2 For general aviation operators, the State of registry will determine if the aircraft meets the applicable APV/baro-VNAV requirements (see Paragraph 2.5.2.2 of Annex 6, Part II).

10. AIRWORTHINESS APPROVAL

10.1 Equipment requirements

10.1.1 APV/baro-VNAV procedures are to be used by aircraft equipped with flight management systems (FMS) or other RNAV or RNP systems capable of calculating barometric VNAV paths and, based on these, display deviations on the instrument visual indicator.

10.1.2 Aircraft equipped with APV/baro-VNAV systems that have been approved by the State of registry for the corresponding level of lateral navigation operations (LNAV)/VNAV may use these systems to conduct APV/baro-VNAV approaches, provided:

a) the navigation system has a certified performance of 0.3 NM or lower, with a 95% probability. This includes:

    1) global navigation satellite systems (GNSS) certified for approach operations; o

    2) multiple-sensor systems that use inertial reference units (IRU) in combination with dual distance measuring equipment (DME/DME) or certified GNSS systems; o

    3) RNP systems approved for operations with RNP 0.3 or lower.

b) the APV/baro-VNAV equipment is operational;

c) the aircraft and the aircraft systems are properly certified for the planned APV/baro-VNAV approach operations;

d) the aircraft is equipped with an integrated LNAV/VNAV system with an accurate source of barometric altitude; and

e) VNAV altitudes and all the relevant procedural and navigation information are obtained from a navigation database whose integrity is supported by appropriate quality assurance measures.

10.1.3 In cases where LNAV/baro-VNAV procedures have been published, the approach area will be assessed in order to identify obstacles invading the inner approach surfaces, the inner transitional surfaces, and the balked landing surface defined of Annex 14 to the Chicago Convention. If obstacles invade these surfaces, a restriction amounting to the minimum value of the allowed OCA/H will be imposed.

10.1.4 APV/baro-VNAV operations are based on RNAV/RNP systems that receive inputs from equipment that may include:

a) an air data computer: FAA Technical Standard Order (TSO)-C 106.

b) an air data system: Aeronautical Radio, Incorporated (ARINC) 706, Mark 5 Air Data System.

c) a barometric altimetry system of the following types: DO-88 altimetry, ED-26 MPS for airborne altitude measurements and coding systems, ARP-942 pressure altimeter systems, ARP-920 design and installation of pitot static systems for transport aircraft.

d) integrated type-certified systems providing the capabilities of an air data system comparable to the one described in paragraph b).

Note 1.- *Position data from other sources may be integrated with the barometric altitude information, provided they do not cause position errors exceeding the path-keeping precision requirements.*

Note 2.- *The altimetry system performance will be demonstrated separately through the certification of static pressure systems (e.g., *14 CFR 25.1325 or *CS 25.1325 or equivalent sections), where performance must be 30 ft by 100 knots of indicated airspeed (KIAS). Altimetry systems that meet this requirement will meet the altimetry system error (ASE) requirements for baro-VNAV operations. Additional compliance or demonstration is not required.*

**14 CFR 25.1325: Section 1325 of Part 25 of Title 14 of the United States Code of Federal Regulations (CFR).*

**CS 25.1325: Certification Specification (CS) 25.1325 of EASA certification specifications for large aircraft (CS 25).*

10.1.5 Continuity of function.- At least one RNAV system is required to conduct baro-VNAV operations.

10.2 System accuracy

10.2.1 For instrument approach operations, it must be demonstrated that the on board VNAV equipment error, excluding altimetry, is lower than the values described in Table 10-1, with a probability of 99.7%.

Table 10-1

	Level flight segments and climb/descent intercept altitude region of specified altitudes (ft)	Climbs/descents along the specified vertical profile (angle) (ft)
At or below 5 000 ft	50	100
5 000 ft to 10 000 ft	50	150
Above 10 000 ft	50	220

Note 1.- *The VNAV equipment error is the error associated with the calculation of the vertical path. This includes the path definition error (PDE) and an approach performed by the VNAV equipment from the construction of the vertical path, if any.*

10.2.2 Vertical flight technical errors (FTE).- Using satisfactory displays of vertical guidance information, it must be demonstrated that the flight technical errors are below the values shown in Table 10-2, on a three-sigma basis:

Table 10-2

	Level flight segments and climb/descent intercept altitude region of specified altitudes (ft)	Climbs/descents along the specified vertical profile (angle) (ft)
At or below 5 000 ft	150	200
5 000 ft to 10 000 ft	240	300
Above 10 000 ft	240	300

10.2.3 Regarding the facility, a sufficient number of test flights should be conducted to verify that these values could be maintained. Lower FTE values can be achieved, especially when the VNAV system is coupled to an AP or FD. However, at least the total system vertical precision shown in Table 10-3 must be maintained.

10.2.4 If a facility produces higher FTEs, the total vertical error of the system (excluding altimetry) can be determined by combining the FTEs with the equipment errors using the root sum square method. The result shall be lower than the values listed in Table 10-3:

Table 10-3

	Level flight segments and climb/descent intercept altitude region of specified altitudes (ft)	Climbs/descents along specified vertical profile (angle) (ft)
At or below 5 000 ft	158	224
5 000 ft to 10 000 ft	245	335
Above 10 000 ft	245	372

10.2.5 The approval of the VNAV system in accordance with FAA AC 20-129, and the approval of the altimetry system in accordance with FAR/CS/LAR 25.1325 or equivalent, constitutes acceptable means of compliance with the aforementioned precision requirements.

10.3 functional requirements for APV/baro-VNAV operations

10.3.1 **Required functions**

a) **Displays**.- APV/baro-VNAV deviations must be shown on a vertical deviation display (*e.g.,* the horizontal situation indicator (HSI), the enhanced horizontal situation indicator (EHSI), and the vertical deviation indicator (VDI)).

This display must be used as primary flight instrument during the approach. The display must be visible to the pilot and be located in the primary field of view of the pilot.

The deviation display must have a suitable full-scale deflection based on the required vertical track error.

b) **Continuous deviation display**.- The navigation display must provide the capacity of continuously showing the aircraft position relative to the defined vertical path to the pilot flying the aircraft (PF), on the primary navigation flight instruments. The display must permit the pilot to readily note if the vertical deviation exceeds +100/-50 ft. The deviation shall be monitored and the pilot will take the appropriate action to minimise errors.

Note.- *When the minimum crew consists of two pilots, a means shall be provided for the pilot not flying the aircraft (PNF) (pilot monitoring (PM)) to check the desired path and the aircraft position relative to the path.*

1) It is recommended that a properly graduated non-numerical deviation display (*e.g.,* the vertical deviation indicator) be located on the primary field of view of the pilot. A fixed-scale deviation indicator is acceptable, provided said indicator demonstrates the proper setting and

sensitivity for the planned operation. Alert and annunciation limits must also correspond to scale values.

Note.- *Current systems incorporate vertical deviation scales in the range of ± 500 ft. These deviation scales shall be assessed based on the aforementioned requirements.*

2) Instead of duly graduated vertical deviation indicators, it may be acceptable to have a numeric vertical deviation display, depending on the flight crew workload and display characteristics. The use of a numerical display may require initial and recurrent training for the flight crew.

3) Since the vertical deviation scale and sensitivity vary significantly, an eligible aircraft may also be equipped with an operational FD or AP capable of following a vertical path.

c) **Definition of the vertical path**.- The navigation system must be capable of defining a vertical path in accordance with the published vertical path. It must also be capable of specifying a vertical path within the altitude constraints at two fixes in the flight plan. Altitude constraints at fixes must be defined as one of the following:

1) an AT or ABOVE altitude constraint (for example, 2400A may be appropriate when there is no need to limit the vertical path);

2) an AT or BELOW altitude constraint (for example, 4800B may be appropriate when there is a need to limit the vertical path);

3) an AT altitude limitation (for example, 5200); or

4) a WINDOW-type altitude constraint (for example, 2400A3400B).

Note.- *For RNP AR APCH procedures, any segment with a published path will define that path based on an angle to the fix and altitude.*

d) **Path construction**.- The system must be capable to construct a path to provide guidance from current position to a vertically constrained fix.

e) **Capability to load procedures from the navigation database**.- The navigation system must have the capability to load and modify the entire procedures to be flown, based upon ATC instruction, into the RNAV/RNP system from onboard navigation database. This includes the approach (including vertical angle), the missed approach, and the approach transitions for the selected aerodrome and runway. The RNAV/RNP system shall preclude modification of the procedure data contained in the navigation database.

f) **User interface (control and displays)**.- the display readout and entry resolution for vertical navigation information shall be as follows:

Table 10-4

<table>
<tr><td colspan="2">Parameters</td><td>Display resolution</td><td>Entry resolution</td></tr>
<tr><td rowspan="2">Altitude</td><td>Above the transition level altitude</td><td>Flight level</td><td>Flight level</td></tr>
<tr><td>Below the transition level altitude</td><td>1 ft</td><td>1 ft</td></tr>
<tr><td colspan="2">Vertical path deviation</td><td>10 ft</td><td>Not applicable</td></tr>
<tr><td colspan="2">Flight path angle</td><td>0.1º</td><td>0.1º</td></tr>
<tr><td colspan="2">Temperature</td><td>1º</td><td>1º</td></tr>
</table>

g) The navigation database must contain the necessary information to fly the APV/baro-VNAV approach. This database must contain the Wets and associated vertical information (obstacle clearance height (TCH) and flight path angle (VPA)) for the procedure.

Vertical constraints (altitudes and airspeeds) associated with published procedures must be automatically retrieved from the navigation database once the approach procedure has been selected.

h) The navigation system must be capable of indicating the navigation loss (*e.g.,* system failure) in the pilot's primary field of view through a warning signal (flag) or equivalent indicator on the vertical navigation display.

i) The aircraft must show barometric altitude from two independent altimetry sources, one in each pilot's primary field of view. When single pilot operation is permitted, the two displays must be visible from the pilot position.

10.3.2 **Recommended functions**

a) **Temperature compensation** The baro-VNAV navigation system should be capable of automatically adjusting the vertical flight path for temperature effects. The equipment should provide the capability for entry of altimeter source temperature to compute temperature compensation for the vertical flight path angle. The system should provide clear and distinct indication to the flight crew of this compensation/adjustment.

b) Capability to automatically intercept the vertical path at the final approach point (FAP), using a vertical fly-by technique.

10.4 Aircraft eligibility

a) **RNP system capability.-** An aircraft is eligible for RNP operations when it meets the RNP performance and functional requirements described in SRVSOP AC 91-008 (RNP APCH) or AC 91-009 (RNP AR APCH) or equivalents.

b) **Barometric VNAV capability.**- An aircraft is eligible when it has a flight manual (AFM) or AFM supplement which clearly states that the VNAV system is approved for approach operations in accordance with FAA AC 20-129 or AC 20-138 o equivalents documents. In addition, for a VNAV system to be approved for approach operations according to AC 20-129 or AC 20-138 or equivalents documents, it must have a vertical deviation indicator (VDI). Since VDI sensitivity and setting vary significantly, an eligible aircraft must also be equipped and use either a flight director (FD) of an autopilot (AP) capable of following the vertical path. Pilot deviation of +100/-50 ft is considered acceptable on a published VNAV path.

__Note.-__ An aircraft with RNP AR APCH authorisation is considered eligible for conducting baro-VNAV operations in accordance with this AC. No further evaluation is required.

c) **Database requirements.-** The aircraft database must include the WPTs and the associated VNAV information, *e.g.,* altitudes and vertical angles for the procedure to be flown.

10.5 Aircraft approval

a) **Eligibility based on the AFM or AFM supplement**

1) **LAR 91 operators**

LAR 91 operators must review the aircraft AFM or AFM supplement in order to establish the eligibility of the navigation system as described in Paragraph 10.4.

2) **LAR 121 y 135 operators**

(a) LAR 121 and 135 operators must present the following documentation to the CAA:

(1) the sections of the AFM or AFM supplement that document the RNAV/RNP airworthiness approval for APV/baro-VNAV approach procedures in accordance with Paragraph 10.4 of this AC.

b) **Eligibility that is not based on the AFM or AFM supplement**

1) An operator may not be in a position to determine the eligibility of the equipment for conducting APV/baro-VNAV approaches based on the AFM or AFM supplement. In this case, LAR 91, LAR 121 and 135 operators must request that the Airworthiness inspection division of the CAA or equivalent, assess the baro-VNAV equipment to determine its eligibility.

2) Together with the request, the operator will provide to the Airworthiness inspection division or equivalent the following information:

(a) name of the manufacturer, model, and part number of the RNAV/RNP system;

(b) any evidence of IFR approval of the navigation system; and

(c) relevant information about flight crew operating procedures.

3) If the Airworthiness inspection division or equivalent is not in a position of determining the eligibility of the equipment, it shall send the request, together with the supporting data, to the Aircraft certification division or equivalent.

4) The Aircraft certification division or equivalent will verify that the aircraft and the RNAV/RNP system meet the baro-VNAV criteria and that the system can safely fly VNAV paths associated to instrument approach procedures, applying a DA instead of an MDA. The Aircraft certification division or equivalent will provide written documentation (*e.g.,* a report of an amended flight standard bulletin or other official document) to verify the eligibility of the equipment.

5) **For LAR 91 operators**.- If the CAA determines that the navigation equipment is eligible for baro-VNAV instrument approach operations, the Airworthiness inspection division or equivalent will provide documentation showing that the aircraft equipment is approved for said operations.

6) **For LAR 121 and 135 operators**.- The CAA will try to establish the eligibility of the system and will make sure that training and operation manuals reflect the operational policies of Paragraphs 12, 13 and 14 of this AC.

7) Compliance with airworthiness or equipment installation requirements, by itself, does not constitute operational approval.

10.6 Aircraft modification

a) If any system required for baro-VNAV operations is modified (*e.g.,* change in the software or hardware), the aircraft modification must be approved.

b) The operator must obtain a new operational approval that is supported by operational and aircraft qualification documentation presented by the operator.

11. OPERATIONAL APPROVAL

11.1 To obtain the operational approval, the operator will take the following steps:

a) *Airworthiness approval*.- aircraft shall have the corresponding airworthiness approvals as established in Paragraph 10.

b) *Application*.- The operator will submit the following documentation to the CAA:

1) *the application to obtain the APV/baro-VNAV authorization*;

2) *aircraft qualification documentation*.- Documentation showing that the equipment of the proposed aircraft meets the requirements described in Paragraph 10 of this AC.

3) *Type of aircraft and description of the aircraft equipment to be used*.- The operator will

provide a configuration list describing in detail the relevant components and the equipment to be used in the APV/baro-VNAV operation. The list shall include each manufacturer, model and version of the FMS software installed.

***Note**.- Barometric altimetry and the associated equipment, such as air data systems, are basic capabilities required for flight operations.*

4) *Operational procedures*.- Operator manuals shall properly indicate the navigation procedures identified in Paragraphs 12 and 13 of this AC. LAR 91 operators shall confirm that they will operate applying identified practices and procedures.

5) *Training programmes*.- LAR 121 and 135 operators will submit the training curriculums in accordance with Paragraph 14 of this AC, which describe the operational and maintenance practices and procedures and training aspects related to VNAV approach operations (*e.g.,* initial, promotion, and recurrent training for flight crews, flight dispatchers, and maintenance personnel).

***Note.-** A separate training programme is not required if RNAV and VNAV training is already part of the training programme of the operator. However, it should be possible to identify the practices and procedures concerning VNAV aspects covered in the training programme. LAR 91 operators should be familiar with the practices and procedures identified in Paragraph 14 of this AC.*

6) *Operations manual (OM) and checklists*.- Operators will submit the operations manuals and checklists containing information and guidance on APV/baro-VNAV operations.

7) *Maintenance procedures*.- The operator will submit the maintenance procedures containing airworthiness and maintenance instructions concerning the systems and equipment to be used in the operation. The operator will provide a procedure to remove and restore the APV/baro-VNAV operational capacity of the aircraft.

8) *MEL*.- The operator will submit any revision to the MEL needed to conduct APV/baro-VNAV operations.

9) *Validation*.- The CAA will determine the need to conduct validation tests based on the type of operation and operator experience. If validation tests are necessary, the operator will submit a validation test plan to show its capacity to conduct the proposed operation (see Chapter 13 of Volume II, Part II of the SRVSOP Operations Inspector Manual). The validation plan must at least include the following:

    (a) a statement indicating that the validation plan has been designated to demonstrate the capacity of the aircraft to execute APV/baro-VNAV procedures;

    (b) operational and dispatch procedures; and

    (c) MEL procedures.

***Note 1**.- the validation plan shall make use of ground training devices, flight simulators, and aircraft demonstrations. If the demonstration will be conducted in an aircraft, it must be completed during the day and under VMC.*

***Note 2.**- validations may be required for each manufacturer, model, and version of the installed FMS software.*

10) *Navigation data validation program*.- The operator shall submit the details of the navigation data validation program as described in Appendix 1 of this AC.

c) *Training*.- Once the CAA has accepted or approved the amendments to the manuals, programmes and documents submitted, the operator will provide the respective training to its personnel.

d) *Validation flights*.- Validation flights, if required, will be conducted according to Paragraph 11.1 b) 9).

e) *Issuance of the authorisation*.- Once all the aforementioned steps have been completed satisfactorily, the CAA will issue the OpSpecs for LAR 121 and 135 operators, or a LOA for LAR 91.

12. OPERATIONAL PROCEDURES

12.1 For APV/baro-VNAV operations, the crews must be familiar with the following procedures:

a) **Corrections for cold temperatures**.- Pilots are responsible for any cold temperature correction required at all minimum altitudes/heights published. This includes:

a) The altitudes/heights for initial and intermediate segments;

b) The DA/H; and

c) Subsequent missed approach altitudes/heights.

Note.- *The VPA of the final approach path is protected against the effects of cold temperatures by the procedure design.*

b) **Altimeter setting**.- APV/baro-VNAV operations will only be conducted when:

1) a current and local source for altimeter setting is available; and

2) the *QNH/*QFE is properly selected in the aircraft altimeter.

*QNH: Pressure at mean sea level. This setting indicates the altitude above mean sea level, (MSL) with standard temperature.

*QFE: Standard atmosphere that corresponds to 1013 hPa or 29.92" Hg. This setting indicates the altitude above the isobaric surface of 1013 hPa, with standard temperature.

Note.- *A remote source for altimetry setting shall not be used.*

c) **Actions to be taken at the DA**.- The flight crew is expected to operate the aircraft along the published vertical path, and to execute a missed approach procedure once it reaches the DA, unless the required visual references to continue with the approach are in sight.

d) **Temperature limitation**.- Because of the pronounced effect of nonstandard temperature on baro-VNAV operations, instrument approach procedures will contain a temperature limitation below which the use of a vertical navigation decision altitude (VNAV DA) based on baro-VNAV is not authorized. The temperature limitation will be shown through a note in the instrument approach procedure. If the aircraft system is capable of temperature compensation, the crew must follow the operator procedures based on the manufacturer instructions.

e) **VNAV path mode selection**.- The flight crew must know the correct selection of the vertical mode(s) that command vertical navigation via the published flight path. Other vertical modes, such as vertical speed are not applicable to baro-VNAV approach.

f) **Restriction to using a remote source for altimeter setting**.- The use of baro-VNAV up to a DA is not authorised if the altimeter setting is issued from a remote source. For APV/baro-VNAV operations, a current altimetry setting is required for the landing aerodrome. When minima related to a remote altimetry setting are shown, the VNAV function can be used, but only up to the published lateral navigation minimum descent altitude (LNAV MDA).

g) **Manual adjustments**.- If manual adjustments to stored altitude information are necessary, *e.g.,* cold temperature adjustments, the flight crew must make appropriate adjustments to the procedure altitudes and revert to use of the temperature adjusted LNAV MDA.

13. TEMPERATURE LIMITATIONS

a) For aircraft using barometric vertical navigation without temperature compensation to conduct the approach, cold temperature limits are reflected in the procedure design and identified along with any high temperature limits on the charted procedure. Cold temperatures reduce the actual glidepath angle, while high temperatures increase the glidepath angle. Aircraft using barometric vertical navigation with temperature compensation or aircraft using an alternate means of vertical guidance (*e.g.,* satellite-based augmentation system (SBAS)) may disregard the temperature restrictions.

b) Since the temperature limits established in the charts are only assessed for obstacle clearance in the final approach segment, and since temperature compensation only affects vertical guidance, the pilot may need to adjust the minimum altitude on the initial and intermediate approach segments, and at the decision altitude/height (DA/H)).

Note 1*.- Temperature affects the indicated altitude. The effect is similar to having high and low pressure changes, but not as significant as such changes. When the temperature is higher than standard (temperature under international standard atmospheric (ISA) conditions)), the aircraft will be flying above the indicated altitude. When the temperature is below the standard, the aircraft will be flying below the altitude indicated in the altimeter. For further information, refer to altimetry errors in the aeronautical information manual (AIM)*

Note 2.*- The ISA standard conditions at sea level are:*

- *The standard temperature is defined as 15º Celsius (centigrade's) or 288.15º Kelvin;*
- *The standard pressure is defined as 29.92126 inches of mercury (Hg) or 1013.2 hectopascals (hPa); and*
- *The standard density for these conditions is 1.225 kg/m^3 or 0.002377 slugs/cubic ft.*

14. TRAINING PROGRAMME

14.1 The training programme of the operator shall include sufficient training on aircraft VNAV capabilities for flight crews and flight dispatchers (*e.g.,* ground training, flight simulators, flight training devices (FTD) or aircraft). Training will cover the following areas:

a) information about this AC;

b) the meaning and proper use of aircraft systems;

c) the characteristics of APV/baro-VNAV procedures, as determined from chart depiction and textual description;

1) description of WPT types (fly-by and flyover WPTs), path terminators, and any other type of terminator used by the operator, as well as the associated flight paths of the aircraft;

2) information about the specific RNAV/RNP system;

3) automation levels, annunciation modes, changes, alerts, interactions, reversions, and degradation;

4) functional integration with other aircraft systems;

5) the meaning of vertical path discontinuities and related flight crew procedures;

6) monitoring procedures for each flight phase (*e.g*., monitoring of "PROGRESS" o "LEGS" pages);

7) turn anticipations, taking into account the effect of airspeed and altitude; and

8) interpretation of electronic displays and symbols.

d) VNAV equipment operating procedures, where applicable, including how to perform the following actions:

1) adhere to speed and/or altitude constraints associated with an approach procedure;

2) verify WPTs and flight plan programming;

3) fly direct to a WPT;

4) determine vertical track error/deviation;

5) insert and delete route discontinuity;

6) change destination and alternate aerodromes;

7) contingency procedures for VNAV failures;

e) the functioning of barometric altimeters.- Barometric altimeters are calibrated to indicate the true altitude under ISA atmospheric conditions. If, on a given day, the temperature is warmer than ISA, the true altitude will be higher than indicated altitude. Conversely, on a day colder than ISA, the true altitude will be lower than indicated altitude. These errors increase in magnitude as the altitude above the altimeter setting source increases.

f) altimetry setting procedures and cold temperatures.

1) Altimeter setting.- Flight crews must take precautions when changing the altimeter setting and will request a current altimeter setting if the reported setting may not be recent, especially when pressure tends to drop quickly. Remote altimeter setting is not permitted for APV/baro-VNAV operations.

2) Cold temperatures.- In case of cold temperatures, the pilot shall verify the instrument approach procedure chart to determine the temperature limit for using the baro-VNAV capability. If the aircraft system has temperature compensation capability, the crew shall follow the procedures established by the operator based on the manufacturer instructions for using the baro-VNAV function.

g) Knowledge of failures and reversal modes.- The flight crew shall have knowledge of failures and reversal modes that adversely impact the aircraft's ability to conduct baro-VNAV approach operations. In addition, the flight crew must be aware of contingency procedures (*e.g.,* reversal to LNAV MDA following a VNAV failure).

h) Operational verification of altimeters.- When two pilots are required on an aircraft, the flight crew must complete an altimetry crosscheck ensuring both pilots´ altimeters agree within ± 100 ft prior to the FAF. If the altimeter crosscheck fails, the instrument approach procedure must not be executed, or, if said procedure is in progress, it must not be continued. If the avionics system provides a warning system that compares the pilots´ altimeters, flight crew procedures shall indicate the action to be taken in the event of a warning from the pilot altimeter comparator when executing an APV/baro-VNAV operation.

Note.- *This operational crosscheck of the altimeters is not necessary if the aircraft automatically compares the altitudes within 100 ft.*

15. NAVIGATION DATABASE

a) The operator must obtain the navigation database from a qualified supplier that complies with RTCA document DO-200A / EUROCAE ED- 76, Standards for processing aeronautical data.

b) Navigation data suppliers must have a letter of acceptance (LOA) in order to process the navigation information (*e.g.,* FAA AC 20-153 or European aviation safety agency (EASA) document on the conditions for the issuance of letters of acceptance for navigation database suppliers by the Agency (EASA IR 21 Sub-part G) or equivalent documents). A LOA recognizes the data of a supplier as those in which information quality, integrity, and quality management practices are consistent with the criteria of document DO-200A/ED-76. The operator's database supplier (*e.g.,* an FMS company) must have a Type 2 LOA and their respective suppliers must have a Type 1 or 2 LOA.

c) The operator must report to the navigation data provider any discrepancy that invalidates a procedure, and prohibit the use of the affected procedures by means of a notice to flight crews.

d) Operators should consider the need to periodically verify the navigation databases, in order to maintain the existing requirements of the quality system or safety management system.

16. OVERSIGHT, INVESTIGATION OF NAVIGATION ERRORS AND WITHDRAWAL OF APV/baro-VNAV AUTHORISATION

a) The operator will establish a procedure to receive, analyse, and follow up on navigation error reports in order to determine appropriate corrective actions.

b) Information that indicates the potential of repeated errors may require modification of an operator's training programme.

c) Information that attributes multiple errors to a particular pilot may required remedial training or license review.

d) Repeated navigation errors attributed to a piece of equipment or a specific part of that piece of equipment or to operational procedures can entail the cancellation of an operational approval (withdrawal of APV/baro-VNAV authorisation from the OpSpecs or withdrawal of the LOA in the case of private operators).

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APPENDIX 1

NAVIGATION DATA VALIDATION PROGRAMME

1. INTRODUCTION

The procedure stored in the navigation database defines the aircraft lateral and vertical guidance. The navigation database is updated every 28 days. The navigation data used in each update are critical for the integrity of each APV/baro-VNAV approach. Taking into account the reduced obstacle clearance associated with these approaches, navigation data validation requires special consideration. This appendix provides guidance on the operator procedures to validate the navigation data associated with APV/baro-VNAV approaches.

2. DATA PROCESSING

a) The operator will identify the person responsible for updating the navigation data.

b) The operator must document a process for accepting, verifying, and loading the navigation data into the aircraft.

c) The operator must place its documented data process under configuration control.

3. INITIAL DATA VALIDATION

3.1 The operator must validate every APV/baro-VNAV procedure before flying the procedure in instrument meteorological conditions (IMC) to ensure compatibility with their aircraft and to ensure the resulting path correspond to the published procedure. As a minimum, the operator must:

a) compare the navigation data of the procedure to be loaded on the FMS with a published procedure.

b) validate the navigation data of the loaded procedure, either in the flight simulator or in the actual aircraft under visual meteorological conditions (VMC). The depicted procedure on the map display must be compared to the published procedure. The entire procedure must be flown to ensure that the path can be used, that it has no apparent lateral or vertical path disconnections, and is consistent with the published procedure.

c) once the procedure is validated, a copy of the validated navigation data must be kept and maintained to be compared with subsequent data updates.

4. DATA UPDATING

Whenever the operator receives a navigation data update and before using such data on the aircraft, the update must be compared with the validated procedure. This comparison must identify and resolve any discrepancy in the navigation data. If there are any significant changes (any change affecting the approach path or performance) to any part of the procedure, the operator must validate the amended procedure in accordance with the initial data validation (Paragraph 3 of this AC).

5. NAVIGATION DATA SUPPLIERS

Navigation data suppliers must have a letter of acceptance (LOA) to process these data (*e.g.,* FAA AC 20-153 or EASA document on the conditions for the issuance of letters of acceptance for navigation data suppliers (EASA IR 21 Sub-part G) or equivalent document). An LOA recognizes the data of a supplier as having an information quality; integrity and quality management practices that are consistent with the criteria of document DO-200A/ED-76. The operator's database supplier must have a Type 2

LOA and their respective suppliers must have a Type 1 or 2 LOA. The AAC may accept a LOA submitted by navigation data suppliers or issues its own LOA.

6. AIRCRAFT MODIFICATIONS (DATA BASE UP TO DATE)

If an aircraft system required for APV/baro-VNAV operations is modified (*e.g.,* a change in the software), the operator is responsible for validation of APV/baro-VNAV procedures with the navigation database and the modified system. This may be accomplished without any direct evaluation if the manufacturer verifies that the modification has no effect on the navigation database or on path computation. If this verification is not accomplished by the manufacturer, the operator must carry out an initial navigation data validation with the modified system.

APPENDIX 1

APV/baro-VNAV APPROVAL PROCESS

a) The APV/baro-VNAV approval process consists of two types of approvals: the airworthiness and operational approvals. Although the two have different requirements, they must be considered under a single process.

b) This process constitutes an orderly method used by the CAAs to ensure that applicants meet the established requirements.

c) The approval process consists of the following phases:

1)	Phase one:	Pre-application
2)	Phase two:	Formal application
3)	Phase three:	Review of the documentation
4)	Phase four:	Inspection and demonstration
5)	Phase five:	Approval

d) In *Phase one - Pre-application*, the CAA meets with the applicant or operator (pre-application meeting), who is advised of all the requirements it must meet during the approval process.

e) In *Phase two - Formal application*, the applicant or operator submits the formal application, accompanied by all the relevant documentation, as established in Paragraph 11 of this AC.

f) In *Phase three - Review of documentation*, the CAA evaluates the documentation and the navigation system to determine their eligibility and the approval method to be applied with respect to the aircraft. As a result of this review and evaluation, the CAA may accept or reject the formal application together with the documentation.

g) In *Phase four - Inspection and demonstration*, the operator will train its personnel and conduct validation flights, if required.

h) In *Phase five - Approval*, the CAA issues the APV/baro-VNAV authorization once the operator has met the airworthiness and operational requirements. For LAR 121 and 135 operators, the CAA will issue the corresponding OpSpecs, and for LAR 91 operators, it will issue a LOA.

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APPENDIX G-2

APV/baro-VNAV JOB AID

APPLICATION TO CONDUCT APV/baro-VNAV OPERATIONS

APV/baro-VNAV JOB AID

APPLICATION TO CONDUCT APV/baro-VNAV OPERATIONS

1. Introduction

This Job Aid was developed by the Latin American Regional Safety Oversight Cooperation System (SRVSOP) to provide States, operators, and inspectors with guidance on the process to be followed by an operator in order to obtain an APV/baro-VNAV authorization.

2. Purpose of the Job Aid

2.1 To give operators and inspectors information on the main APV/baro-VNAV reference documents.

2.2 To provide tables showing the contents of the application, the associated reference paragraphs, the place in the application of the operator where APV/baro-VNAV elements are mentioned and columns for inspector comments and follow-up on the status of various elements of APV/baro-VNAV.

3. Actions Recommended for the inspector and operator

Some recommendations for use of the Job Aid follow:

3.1 At the pre-application meeting with the operator, the inspector reviews the "basic events of the APV/baro-VNAV approval process" described in Part 1 of this Job Aid, in order to provide an overview of the approval process events.

3.2 The inspector reviews this Job Aid with the operator in order to establish the form and content of the APV/baro-VNAV approval application.

3.3 The operator uses this Job Aid as a guide to collect the documents/annexes of the APV/baro-VNAV application.

3.4 The operator inserts in the Job Aid references showing in what part of its documents are the APV/baro-VNAV programme elements located.

3.5 The operator submits the Job Aid and the application to the inspector (documents/annexes).

3.6 The inspector indicates in the Job Aid whether an item is in compliance or needs corrective action.

3.7 The inspector informs the operator as soon as possible when a corrective action by the operator is required.

3.8 The operator provides the inspector with the revised material when so requested.

3.9 The CAA provides the operator with the operational specifications (OpSpecs) or a letter of authorisation (LOA), as applicable, when the tasks and documents have been completed.

4. Structure of the Job Aid

5. Main sources of documents, information, and contacts

Advisory Circular CA 91-010 - Approval of aircraft and operators for approach procedures with vertical guidance/barometric vertical navigation (APV/baro- VNAV) operations is available on the ICAO/SAM Regional Office web page (www.lima.icao.int) through the SRVSOP link.

6. Main reference documents

Reference documents	Titles
Annex 6	Operation of aircraft
ICAO Doc 9613	Performance-based navigation (PBN) manual – Attachment A - Barometric VNAV
ICAO Doc 9905	Required navigation performance authorization required (RNP AR) procedure design manual
ICAO Doc 8168 Volume I	Part II, Section 4, Chapter 1 – APV/baro-VNAV approach procedures
ICAO Doc 8168 Volume II	Part III, Section 3, Chapter 4 – APV/baro-VNAV
EASA AMC 20-27	Airworthiness approval and operational criteria for RNP APPROACH (RNP APCH) operations including APV BARO-VNAV operations
FAA AC 90-105	Approval guidance for RNP operations and barometric vertical navigation en the U.S. National Airspace System - Appendix 4 - Use of barometric VNAV
AC 20-129	Airworthiness approval of vertical navigation (VNAV) systems for use in the U.S. national airspace system (NAS) and Alaska
AC 20-138A	Airworthiness approval of Global navigation satellite system (GNSS) equipment
TSO-C106	Air data computer

PART 1: GENERAL INFORMATION

Basic events in APV/baro-VNAV approval process

	Action by the operator	Action by the CAA
1	Establishes the need to obtain the APV/baro-VNAV authorization.	
2	Reviews the AFM, AFM supplement or Type Certificate Data Sheet (TCDS), or other appropriate documents (*e.g.,* service bulletins (SB), service letters (SL), etc.) to determine the eligibility of the aircraft for APV/baro-VNAV operations. The operator contacts the aircraft or avionics manufacturer, if necessary, to confirm APV/baro-VNAV or higher eligibility of the aircraft.	
3	Contacts the CAA to schedule a pre-application meeting to discuss the operational approval requirements.	
4		During the pre-application meeting, establishes: • the form and contents of the application; • the documents that support APV/baro-VNAV approval • the date in which the application will be submitted for evaluation • if necessary, conduct a validation flight observed by the CAA
5	submits the application at least 60 days before start-up of APV/baro-VNAV operations.	
6		Reviews the application of the operator.
7	Once the amendments to manuals, programmes, and documents have been approved or accepted, provides training to flight crews, flight dispatchers, and maintenance personnel, and conducts a validation flight, if required by the CAA.	Only if required, participates in the validation flight.
8		Once the operational and airworthiness requirements have been met, issues the operational approval in the form of OpSpecs for LAR 121 or 135 or equivalent operators, or an LOA for LAR 91 or equivalent operators, as appropriate.

Notes related to the approval process

1. **Responsible authority**

   a. **Commercial air transport (LAR 121 and/or 135 or equivalent regulations).-** The **State of registry** determines that the aircraft meets the airworthiness requirements. The **State of the operator** issues the APV/baro-VNAV approval (*e.g.,* OpSpecs).

   b. **General aviation (LAR 91 or equivalent regulation).-** The **State of registry** determines that the aircraft meets airworthiness requirements and issues the operational approval (*e.g.,* an LOA).

2. The CAA does not need to issue an LOA or equivalent document for each individual area of operation in the case of LAR 91 operators.

3. LAR 121 and/or 135 operators with APV/baro-VNAV approval must list this approval in the OpSpecs.

4. Related sections of the Latin American Aeronautical Regulations (LAR) or equivalent regulations

   a. LAR 91 Sections 91.1015 and 91.1640 or equivalents

   b. LAR 121 Section 121.995 (b) or equivalent

   c. LAR 135 Section 135.565 (c) or equivalent

5. Related ICAO Documents

   a. Annex 6 to the Convention on International Civil Aviation – Operation of aircraft

   b. Annex 10 to the Convention on International Civil Aviation – Aeronautical telecommunications

   c. Annex 15 to the Convention on International Civil Aviation – Aeronautical information services

   d. ICAO Doc 9613 – Performance-based navigation (PBN) manual

   e. ICAO Doc 8168 Volume I and II – Procedures for air navigation services – Aircraft operations

PART 2: INFORMATION ON THE IDENTIFICATION OF AIRCRAFT AND OPERATORS

NAME OF THE OPERATOR: ____

Aircraft manufacturer, model, and series	Registration numbers	Serial numbers	APV/baro-VNAV system Number, manufacturer, and model	RNP navigation specification

DATE OF PRE-APPLICATION MEETING ____

DATE ON WHICH THE APPLICATION WAS RECEIVED ____

DATE ON WHICH THE OPERATOR INTENDS TO BEGIN APV/baro-VNAV OPERATIONS ______________________

IS THE CAA NOTIFICATION DATE APPROPRIATE? YES _____ NO _____

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PART 3 – OPERATOR APPLICATION (ANNEXES AND DOCUMENTS)

Annex	Title of Annex/document	Indication of inclusion by the operator	Comments by the Inspector
A	**Operator letter requesting APV/baro-VNAV authorization**		
B	**Airworthiness documents showing aircraft eligibility for APV/baro-VNAV.** **Eligibility based on the AFM or AFM supplement** AFM, AFM revision, AFM supplement, or Type certificate data sheet (TCDS) showing that the RNAV/RNP navigation system is eligible for APV/baro-VNAV. **Eligibility not based on the AFM or AFM supplement** The applicant will request the CAA to assess the baro-VNAV equipment to determine its eligibility.		
C	**Aircraft modified to meet APV/baro-VNAV standards. Documentation on aircraft inspection and/or modification, if applicable.** Maintenance records documenting the installation or modification of aircraft systems (*e.g.,* FAA Form 337 – major repairs and alterations).		
D	**Maintenance procedures** • For aircraft with established maintenance procedures for APV/baro-VNAV systems, the list of references of the document or programme. • For recently installed RNAV/RNP systems, the maintenance procedures for their review.		
E	**Minimum equipment list (MEL) (only for operators conducting operations based on a MEL):** MEL showing provisions for APV/baro-VNAV systems.		
F	**Training** **1. LAR 91 operators or equivalent: Training methods:** Training at home, LAR 142 training centres, or other training courses, course completion		

Annex	Title of Annex/document	Indication of inclusion by the operator	Comments by the Inspector
	records. **2. LAR 121 and/or 135 operators or equivalent:** Training programmes (training curricula) for flight crews, flight dispatchers, and maintenance personnel.		
G	**Operating policies and procedures** **1. LAR 91 operators or equivalent:** Operations manual (OM) or sections to be attached to the application, corresponding to APV/baro-VNAV operating procedures and policies. **2. LAR 121 and/or 135 operators or equivalent:** Operations manual and checklists.		
H	**Navigation database** Details of the navigation data validation programme.		
I	**Withdrawal of APV/baro-VNAV approval** Indication of the need to follow up on navigation error reports submitted and the possibility of withdrawal of APV/baro-VNAV approval.		
J	**Validation flight plan:** Only if required by the CAA**.**		

CONTENTS OF THE APPLICATION TO BE SUBMITTED BY THE OPERATOR

____ **DOCUMENTATION SHOWING APV/baro-VNAV COMPLIANCE OF THE AIRCRAFT/NAVIGATION SYSTEMS**

____ **OPERATING PROCEDURES AND POLICIES**

____ **SECTIONS OF THE MAINTENANCE MANUAL RELATED TO THE RNAV/RNP SYSTEM (if not previously reviewed)**

Note 1: Documents may be grouped in a single folder or may be sent as individual documents.

PART 4: CONTENT OF THE OPERATOR APPLICATION FOR APV/baro-VNAV OPERATIONS

#	Contents of the APV/baro-VNAV application by the operator	Reference paragraphs CA 91-010	In what Annexes/Documents of the operator can the application contents be located Note: The operator must update this column to reflect the contents of the application	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
1	**Operator request letter** Statement of intent to obtain APV/baro-VNAV authorization..	Paragraph 11.1 b) 1) Appendix 2, paragraph e)	Annex A		
2	**Description of aircraft equipment**	Paragraph 11.1 b) 3)	Annex B		
3	**Eligibility of APV/baro-VNAV systems** Airworthiness documents establishing the eligibility of the APV/baro-VNAV navigation systems, their approval status, and a list of the aircraft for which the approval is being requested.	Paragraph 11.1 b) 2)	Annex B Annex C		
4	**Training programme** **1. LAR 121 or 135 operators or equivalent: Training programmes:** Operators will develop an initial and periodic training programme for flight crews, flight dispatchers, if applicable, and maintenance personnel. **2. LAR 91 operators or equivalent:**	Paragraph 11.1 b) 5) Paragraph 11.1	Annex F		

#	Contents of the APV/baro-VNAV application by the operator	Reference paragraphs CA 91-010	In what Annexes/Documents of the operator can the application contents be located Note: The operator must update this column to reflect the contents of the application	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
	Training methods: The following methods are acceptable for these operators: Training at home, LAR 142 training centres, or other training courses.	b) 5) Note			
5	**Operating procedures** **1. LAR 121 and/or 135 operators or equivalent:** Operations manual and checklists. **2. LAR 91 operators or equivalent:** Operations manual or section of the operator application documenting APV/baro-VNAV policies and procedures.	Paragraph 11.1 b) 4) Paragraph 11.1 b) 6)	Annex G		
6	**Maintenance procedures** • For aircraft with established maintenance practices for APV/baro-VNAV navigation systems, the operator will provide document references. • For newly installed APV/baro-VNAV systems, the operator will provide maintenance practices for review.	Paragraph 11.1 b) 7)	Annex D		

#	Contents of the APV/baro-VNAV application by the operator	Reference paragraphs CA 91-010	In what Annexes/Documents of the operator can the application contents be located Note: The operator must update this column to reflect the contents of the application	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
7	**Update of the minimum equipment list (MEL)** Applicable to operators conducting operations according to a MEL.	Paragraph 11.1 b) 8)	Annex E		
8	**Navigation data validation programme**	Paragraph 11.1 b) 10) Appendix 1	Annex F		
9	**Withdrawal of APV/baro-VNAV approval** Indication of the need for follow-up on the navigation error reports and the possibility of withdrawal of the APV/baro-VNAV approval.	Paragraph 16 d)	Annex H		
10	**Validation flight plan, only if required** The validation flight plan will be presented only if required.	Paragraph 11.1 b) 9)	Annex I		

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PART 5 – GUIDE TO DETERMINE THE ELIGIBILITY OF APV/baro-VNAV AIRCRAFT

#	Topics	Reference paragraphs CA 91-006	Location in the Annexes of the operator	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
1	**APV/baro-VNAV equipment requirements** RNAV/RNP equipment with a certified performance of 0.3 NM or lower, with 95% probability, which includes:	Paragraph 10.1.2 a)	Annex B		
	a) Global navigation satellite systems (GNSS) certified for approach operations; or	Paragraph 10.1.2 a) 1)			
	b) Multi-sensor systems that use inertial reference units (IRU) in combination with dual distance measuring equipment (DME/DME) or certified GNSS systems; or	Paragraph 10.1.2 a) 2)			
	c) RNP systems approved for RNP 0.3 operations or lower.	Paragraph 10.1.2 a) 3)			
2	**Equipment whose input is used by RNAV/RNP systems may include:**	Paragraph 10.1.4	Annex B		
	a) An air data computer: FAA Technical Standard Order (TSO)-C 106.	Paragraph 10.1.4 a)			
	b) An air data system: Aeronautical Radio, Incorporated (ARINC) 706, Mark 5 Air Data System.	Paragraph 10.1.4 b)			

#	Topics	Reference paragraphs CA 91-006	Location in the Annexes of the operator	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
	c) A pressure altimeter system of the following types: DO-88 altimetry, ED-26 MPS for airborne altitude measurements and coding systems, ARP-942 pressure altimeter systems, ARP-920 design and installation of pilot static systems for transport aircraft.	Paragraph 10.1.4 c)			
	d) Integrated systems with type certification that provide an air data system capability comparable to the one described in paragraph 2 b).	Paragraph 10.1.4 d)			
3	Aircraft eligibility	Paragraph 10.4			
	a) RNP system capability Aircraft that meet the performance and functional requirements of SRVSOP CA 91-008 (RNP APCH) or CA 91.009 (RNP AR APCH) or equivalent are eligible for conducting RNP operations.	Paragraph 10.4 a)			
	b) VNAV barometric capability An aircraft is eligible for baro-VNAV operations when the AFM or AFM supplement indicates that the VNAV system has been approved under AC 20-129 or AC 20-138	Paragraph 10.4 b)			

#	Topics	Reference paragraphs CA 91-006	Location in the Annexes of the operator	Comments and/or recommendations by the inspector	Follow-up by the inspector: Item status and date
	c) Aircraft approved to conduct RNP AR APCH operations according to CA 91-009 are eligible for APV/baro-VNAV approaches. No additional assessment is required.	Paragraph 10.4 b) Note			
4	**Approval of aircraft** a) Eligibility based on the AFM or AFM supplement b) Eligibility not based on the AFM or AFM supplement.	Paragraph 10.5 Paragraph 10.5 a) Paragraph 10.5 b)	Annex B		
5	**Modified aircraft**	Paragraph 10.6			
6	**Functional requirements and their explanation** a) Required functions b) Recommended functions	Paragraph 10.3 Paragraph 10.3.1 Paragraph 10.3.2	Annex B		
7	**Maintenance requirements**	Paragraph 11.1 7)	Annex B		
8	**Navigation database** Details of the navigation data validation programme	Paragraph 15 Appendix 1	Annex B		

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PART 6 - BASIC PILOT PROCEDURES FOR APV/baro-VNAV OPERATIONS

Topics		Reference paragraphs CA 91-006	Location in the Annexes of the operator	Comments and/or recommendations by the CAA	Follow-up by the Inspector
Operating procedures		Paragraph 12	Annex G		
1	**Cold temperature corrections**.- Pilots are responsible for any correction for cold temperature required in all published minimum altitudes/heights. This includes: 1) Altitudes/heights for initial and intermediate segments; 2) The DA/H; and 3) Subsequent missed approach altitudes/heights.	Paragraph 12.1 a)			
2	**Altimeter setting**.- APV/baro-VNAV operations will only be conducted when: 1) there is a current and local source for altimeter setting; and 2) QNH/QFE is properly selected in the altimeter of the aircraft.	Paragraph 12.1 b)			
3	**Action to be taken at the DA**.- The flight crew is expected to operate the aircraft along the published vertical path, and to execute a missed approach procedure when reaching the DA, unless it has in view the visual references required to proceed with the approach.	Paragraph 12.1 c)			
4	**Temperature limitation**.- Because of the pronounced effect of non-standard temperature on baro-VNAV operations, instrument approach procedures will contain a temperature limitation below which the use of a vertical	Paragraph 12.1 d)			

	navigation decision altitude (VNAV DA) based on baro-VNAV is not authorised. The temperature limitation will be shown through a note in the instrument approach procedure. If the aircraft system is capable of temperature compensation, the crew must follow the operator procedures based on the manufacturer instructions.				
5	**VNAV path mode selection**.- The flight crew must know the correct selection of the vertical mode(s) that command vertical navigation via the published flight path. Other vertical modes, such as vertical speed are not applicable to baro-VNAV approach.	Paragraph 12.1 e)			
6	**Restriction to using a remote source for altimeter setting**.- The use of baro-VNAV up to a DA is not authorised if the altimeter setting is issued from a remote source. For APV/baro-VNAV operations, a current altimetry setting is required for the landing aerodrome. When minima related to a remote altimetry setting are shown, the VNAV function can be used, but only up to the published lateral navigation minimum descent altitude (LNAV MDA).	Paragraph 12.1 f)			
7	**Manual adjustments**.- If manual adjustments to stored altitude information are necessary, *e.g.,* cold temperature adjustments, the flight crew must make appropriate adjustments to the procedure altitudes and revert to use of the temperature adjusted LNAV MDA.	Paragraph 12.1 g)			

SRVSOP contacts:

Marcelo Ureña Logroño: SRVSOP safety oversight specialist/Aircraft operations e-mail: murena@lima.icao.int

Job Aid: APV/baro-VNAV
Version: Original
Date: 12/10/2009

APPENDIX H

Status of the survey on the PBN capability of the SAM Region Aircraft Fleet

Date: 22/10/2009

State	Was a reply received	Comments
Argentina	YES	1. Only affected aircraft in air commercial aircraft affected 2. In the forms sent, no identification of air operator is found. 3. Information missing for general aviation, superior to 5700 kg. 4. For general aviation information, below 5700 kg. Informs that is not going to be able to submit information in view that it is a complex and enormous effort, in the time frame established
Bolivia	YES	1. Only commercial aviation 2. Information on general aviation is missing
Brazil	YES	1. Only aircraft superior to MTOW 5700 kg; 2. Information missing on RNP AR APCH
Colombia	YES	1. Only commercial aviation; the Electronic submission of this data is essential for the reading of the same. 2. Information is missing on RNP AR APCH.
Chile	YES	Only commercial aviation with aircraft superior to MTOW 5700 kg
Ecuador	YES	1. Only commercial aviation
Guyana	YES	1. Only commercial aviation
French Guyana	YES	1. Only commercial aviation 2. Information missing on RNP AR APCH
Panamá		
Paraguay		
Peru	YES	1. Only commercial aviation with aircraft superior to MTOW 5700 kg 2. Information missing on RNP AR APCH
Uruguay	YES	1. Only commercial aviation
Surinam		
Venezuela		

APPENDIX I

REPORT OF RNAV-5 POTENTIAL – SAM REGION

Reporte de potencial RNAV -5 Región SAM

FL por encima de FL250	X

	Datos		
Estado (State)	Aeronaves	N° Potencial RNAV 5	% Por Estado
Argentina	133	132	99%
Chile	94	91	97%
Brasil	244	221	91%
Guyana Francesa	7	7	100%
Perú	40	40	100%
Ecuador	37	35	95%
Colombia	63	63	100%
Total	618	589	95%

Nota: Los datos de Bolivia, Ecuador y Uruguay se encuentran en proceso.

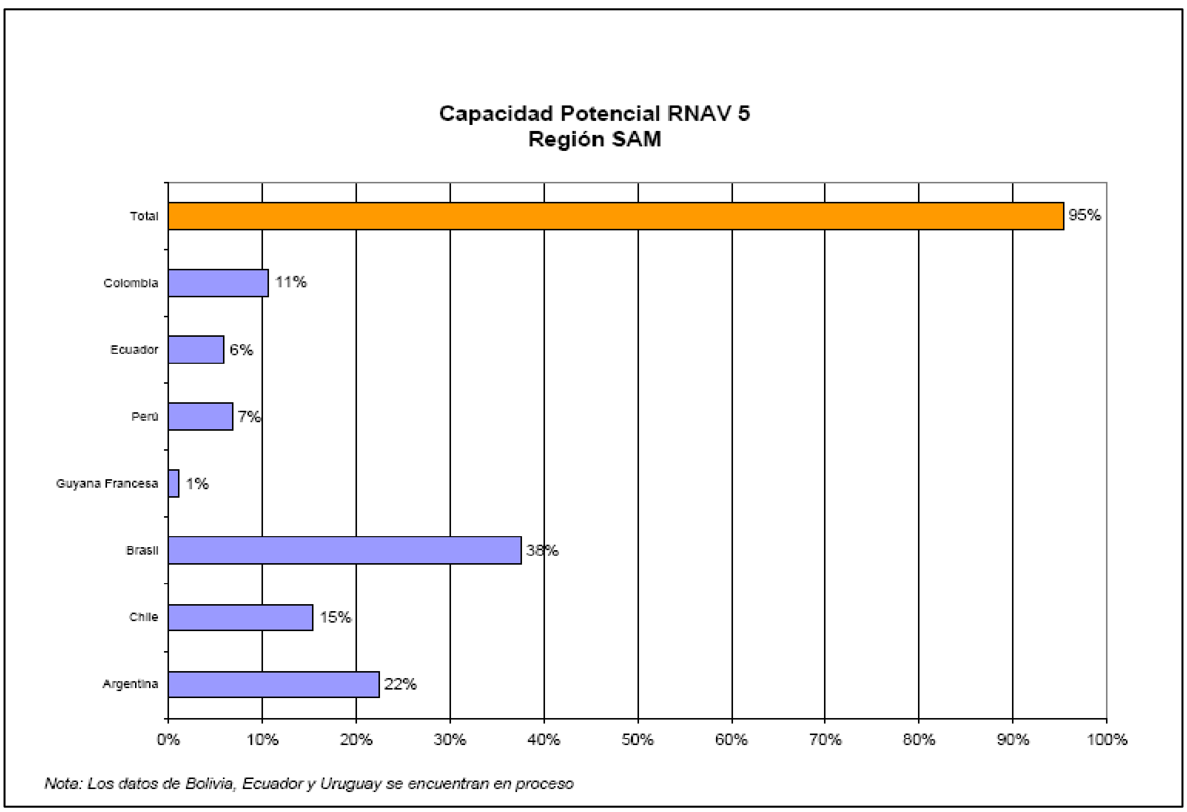

Chart of replies to the Survey on PBN capacity for the SAM Region

APPENDIX J

TRAINING PROGRAMME ON ADVISORY CIRCULARS RELATED WITH PBN APPROVALS

Course on PBN basic concepts and RNAV approvals Lima, Peru, 15 to 19 March 2010	**Course on basic PBN concepts and RNP approvals** Lima, Peru 17 to 21 May 2010
Training Modules	**Training Modules**
➢ PBN Regional Planning ➢ Action plans for PBN implementation ➢ PBN, Basic Concepts, application of PBN navigation specifications ➢ Infrastructure of navigation aids (GNSS, DME/DME, DME/DME/IRU, VOR/DME, INS/IRS); ➢ Aircraft equipment (RNAV/RNP (FMS), multi-sensor equipment, autonomous equipment (INS/IRS); ➢ GNSS, INS/IRS, DME, VOR/DME principles ➢ RNP Performance, onboard performance control and alert (differences between RNAV and RNP Navigation specifications); ➢ RNAV 10 approval (designated and cleared as RNP 10); ➢ RNAV 5; approval; and ➢ RNAV 1 and RNAV 2 approval	➢ Basic PBN Concepts, application of PBN navigation specifications; ➢ Infrastructure of navigation aids (GNSS, DME/DME, DME/DME/IRU, VOR/DME, INS/IRS); ➢ Aircraft equipment RNAV/RNP (FMS), multi-sensor equipment. Autonomous equipment (INS/IRS); ➢ GNSS, INS/IRS, DME, VOR/DME principles ➢ RNP Performance, onboard performance control and alert; ➢ RNP 4 approval; ➢ RNP 1 basic approval; ➢ RNP APCH approval; ➢ RNP AR APCH; approval, and ➢ APV/baro-VNAV approval.

APPENDIX K / APÉNDICE K

Revised work programme for the development of Advisory Circulars related to PBN approval / Programa de trabajo revisado para el desarrollo de las Circulares de Asesoramiento relacionadas con las aprobaciones PBN

Navigation Specifications Especificaciones de Navegación	AC Numbering/ Numeración de las CA	Titles / Títulos	AC to be presented at/ CA a ser presentadas en
RNP 4	91-004	Aircraft and operators approval for RNP 4 operations Aprobación de aeronaves y explotadores para operaciones RNP 4	SAM/IG/5 19 - 23 Apr 2010
*RNP 2	91-005	Aircraft and operators approval for RNP 2 operations Aprobación de aeronaves y explotadores para operaciones RNP 2	*SAM/IG/6 18 - 22 Oct 2010
*RNP 1 advanced *RNP 1 avanzado	91-007	Aircraft and operators approval for advanced RNP 1 operations Aprobación de aeronaves y explotadores para operaciones RNP 1 avanzada	*SAM/IG/6 18 - 22 Oct 2010

(*) Reunión y fechas tentativas / Meeting and tentative dates.

Agenda Item 5: Implementation of air traffic flow management (ATFM) in the SAM Region

5.1 The Meeting reviewed several matters related to ATFM, including the lack of a common methodology to calculate airport and ATC sector capacity. The Meeting also reviewed the information provided by the States regarding the processing and display of data for flow management purposes, surveillance and automation systems to support ATFM, the means available to capture meteorological data, communication systems and CDM processes, coordination between units, the ATFM manual, among other matters. It also analysed the tasks to be carried out by the Regional Project and the ATFM Action Plan.

5.2 The Meeting reviewed the outstanding tasks and ATFM-related matters that had been discussed by the ATFM working group, which resulted in the updating of the ATFM Action Plan.

5.3 Upon reviewing the activities carried out under Regional Project RLA/06/901, the Meeting analysed, *inter alia*, the tasks related to the drafting of the ATFM Manual and the Guidelines for a common methodology for calculating runway and ATC sector capacity.

ATFM Manual

5.4 Upon analysing the first part of the chapters of the ATFM Manual developed between 6 and 17 July 2009 by two consultants, Messrs. Ronald Fischer and Guilherme Francisco de Freitas Lopes, from United States and Brazil, respectively, the Meeting deemed it advisable to make some modifications to it. The approved version appears in **Appendix A,** to this part of the Report.

5.5 In this regard, the Meeting took note of the plans of Regional Project RLA/06/901 to proceed with the second part of the ATFM Manual, to be presented at the SAM/IG/6 Meeting.

5.6 In this sense, the Meeting considered that, once the draft document was ready, it should be sent by e-mail to ATFM focal points for analysis and comments as necessary. Focal points would have 10 days to send their comments before the SAM/IG/6 Meeting.

Methodology for calculating airport and ATC sector capacity

5.7 The Meeting took note that ICAO SARPs stipulated that air traffic flow management (ATFM) would be established in the airspace where air traffic demand some times exceeded, or was expected to exceed, the declared capacity of the air traffic services involved, and recommended that common procedures and methods be defined for determining capacity through regional agreements.

5.8 Under the auspices of Regional Technical Cooperation Project RLA/06/901 *Assistance for the implementation of a regional ATM system, taking into account the ATM operational concept and the corresponding technological support in communications, navigation, and surveillance (CNS)*, a course on calculation of airport and ATC sector capacity was held in March 2009 at CGNA facilities in Rio, Brazil, as a starting point for the standardisation of training of ATM planners of SAM States on this matter.

5.9 The SAM/IG/3 meeting had requested the Regional Project to hire an expert to develop a guide for the application of a common methodology for calculating airport and ATC sector capacity.

5.10 Regarding the document "Guidance for the implementation of a common methodology for calculating capacity", this activity was carried out during the same period in which the ATFM Manual was developed, with the support of Mr. Roberto Arca, from Uruguay.

5.11 Given the status of implementation of ATFM in the Region, and taking into account that there were no major methodological differences in the calculation models used in the Region, the Meeting reviewed the study and recommended the initial implementation of a common methodology with a view to developing a more complete methodology in the future, enriched with the experience acquired during the first implementation phase.

5.12 In this sense, the Meeting approved the Guidance for the implementation of a common methodology for calculating airport and ATC sector capacity, which recommended the use of the Brazilian methodology for calculating airport and ATC sector capacity, to be applied by SAM States in a first phase as a common methodology, taking into account the following:

a) standard training provided to experts of Project member States,

b) use of a model applicable to both airport and ATC sector capacity,

c) low-cost methodology that does not require software tools,

d) does not require the determination of constants from databases that are not yet available in some States,

e) immediate practical experience on the use of the model, resulting in:

- ✓ the creation of a standard statistical database,
- ✓ the assessment of the weaknesses of the model,
- ✓ feedback to improve the model,
- ✓ experience gained for the definition of a definitive future common model for the SAM Region in a second phase,

f) according to the status of implementation of the regional ATFM, it is possible to leave for the near future the selection of a single definitive regional model for calculating capacity, as recommended by ICAO Annex 11, and

g) it supplements the implementation of some methodologies used in the Region, and is not so different from the calculation of airport acceptance rates applied in Colombia in this first phase.

5.13 Likewise, the Brazilian Administration provided additional information on the calculation of the minimum number of aircraft that needed to be timed by each controller, as shown in **Appendix B** to this part of the report.

5.14 Based on the above, and in order to take advantage of the training provided under ICAO Regional Project RLA/06/901, which standardised the calculation criteria for the Region, to be used in a first phase as a common methodology for calculating airport and sector capacity, the Meeting deemed it advisable to formulate the following Conclusion:

Conclusion SAM/IG/4-5 - Guidance for the application of a common methodology for calculating airport and ATC sector capacity

The Guidance for the application of a common methodology for calculating airport and ATC sector capacity, shown in **Appendix C** to this part of the report, which recommends that SAM States apply the Brazilian methodology for calculating airport and ATC sector capacity, is approved**.**

CDM Manual

5.15 United States, Europe, and other countries have made great progress in the implementation of the collaborative decision-making (CDM) mechanism, with very good results. Likewise, the ATFM Manual being developed for the SAM Region has a chapter devoted to this mechanism for the implementation of a methodology that covers all the relevant areas of the system.

5.16 Therefore, CDM is a key element for maximising airport and air operations, since it takes into account all the elements of coordination between air navigation service providers, such as flow management units (FMU) and the users of those services; such as aircraft and airport operators.

5.17 The CDM strategy consists of engaging all those involved in the planning process, sharing information on aircraft position, predictions, weather forecasts, and, in general, any aspect that contributes to the efficient operation of a regional airspace system.

5.18 Furthermore, CDM allows the participants of the system to optimise their decisions in collaboration with others, learning about their preferences, limitations, and the actual and foreseen situation.

5.19 Taking into account the experience of more advanced countries in the organisation and use of this mechanism, the Meeting deemed it advisable to develop a basic manual to serve as a guide for the States in the implementation of CDM. In this regard, the Meeting agreed to formulate the following Conclusion:

Conclusion SAM/IG/4-6 - CDM implementation manual for the SAM Region

That Regional Project RLA/06/901 sponsor the development of a CDM implementation manual for the SAM Region, initially focused on ATFM, to serve as a guide for SAM States that have not yet implemented this mechanism. The draft version will be presented at the SAM/IG/5 Meeting.

ATFM tasks to be carried out by the Project

5.20 On this matter, the Meeting deemed it advisable to carry out a course/workshop on air traffic flow management (ATFM), kindly offered by the Brazilian Administration, for planners responsible for ATFM implementation, to be conducted on 22 to 27 March 2010. The Meeting requested the Secretariat to attend this course, to extend the invitation to all SAM States, and to take steps to obtain the sponsorship of Regional Project RLA/06/901 for this course.

5.21 On the other hand, United States kindly offered to give an introductory course/workshop on collaborative decision-making (CDM) for those responsible for ATFM implementation, to be conducted during the first quarter of 2010. In this regard, it requested the Secretariat to invite all SAM States and to take the necessary steps to obtain the sponsorship of Regional Project RLA/06/901 for the participation of the delegates to this course.

5.22 Regarding this course/workshop on CDM, it was considered advisable that it be held in Brazil, immediately after the ATFM course, on 29 to 31 March 2010, in order to optimise travel expenditures by the States.

5.23 Regarding the above, the Meeting noted that the tasks proposed under Regional Project RLA/06/901 for 2010 were as follows:

a) hiring an expert to draft the second part of the ATFM Manual.

b) sponsoring the participation of member States in the ATFM course/workshop in Brazil.

c) hiring an expert to develop a basic manual for CDM implementation in the SAM Region.

d) sponsoring the participation of member States in the CDM course/workshop in Brazil.

Flexible use of airspace (FUA)

5.24 The Meeting took note that the flexible use of airspace is an airspace management concept dealing with the optimisation, balance, and equity in the use of airspace by civil and military users, facilitated through strategic coordination and dynamic interaction, based on the resolutions of the 36^{th} ICAO Assembly, the GPI-1 initiative of the Global Air Navigation Plan (ICAO Doc. 9750) and GREPECAS.

5.25 On the other hand, it was noted that there were activities that required reservation of a certain volume of airspace for their exclusive or special use (SUA) during certain periods of time, due to the characteristics of their flight profile or the risks involved in the operations to be carried out in said volume, and the need for their effective and safe separation from other types of aeronautical activities.

5.26 The flexible use of airspace concept also includes the management of such airspace at the strategic, pre-tactical, and tactical levels--which are independent but closely related--, that must be carried out in a coordinated manner to ensure an efficient use of airspace.

5.27 On the other hand, the efficiency of civil-military coordination procedures must be based on standards and procedures that permit an efficient use of airspace by all users.

5.28 In this regard, it was felt necessary to develop a regulatory framework for those activities requiring a special use of airspace, so as to contribute to the flexible use of such airspace. Reference material presented by the aeronautical authority of Uruguay appears in **Appendix D** to this part of the report.

Activities carried out by the States to calculate runway and ATC sector capacity

5.29 The Meeting took note of the results of the exercise carried out by Paraguay, Venezuela, Bolivia, Peru, and Brazil, pursuant to Conclusion 5 of the SAM/IG/3 meeting (Capacity of the runways at an international airport and of the associated ATC sector).

5.30 The Meeting took note of the information presented by Colombia regarding its FMU operations manual and FMU report.

ATFM Action Plan

5.31 Under this agenda item, the Meeting reviewed the ATFM Action Plan for the SAM Region, and, following a fruitful debate, introduced the corresponding changes as shown in **Appendix E** to this part of the Report.

Administrative matters

5.32 The Meeting deemed it necessary to ask the Secretariat to send a note to the States stressing the need to implement the agreements reached at the SAM/IG/4 Meeting.

APPENDIX A

DRAFT

South American Air Traffic Flow Management Manual (CAR/SAM ATFM Manual)

Draft Version	**1.0**
Date	**July 2009**

FOREWORD

The *Caribbean/South American (CAR/SAM) ATFM Manual* is published by the ATM/CNS Subgroup of the Caribbean/South American Regional Planning and Implementation Group (GREPECAS). It describes air traffic flow management practices and procedures to be applied in the CAR/SAM Regions.

The GREPECAS and its contributory bodies will issue revised editions of the Document as required to reflect ongoing implementation activities. Copies of the *CAR/SAM ATFM Manual* can be obtained by contacting:

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The present edition (Draft Version 1.0) includes all revisions and modifications until July 2009. Subsequent amendments and corrigenda will be indicated in the Record of Amendment and Corrigenda Table, according to the procedure established in page **X**.

Table of Contents

Page

A. Background

A.1 ICAO CNS/ATM Systems received support from the Tenth Air Navigation Conference held in 1991 at ICAO Headquarters in Montreal, Canada. The same year, the CAR/SAM Regional Planning and Implementation Group (GREPECAS) started to work towards a regional application of this new air navigation services concept.

A.2 Further, at the Eleventh Air Navigation Conference (AN-Conf/11, Montreal September 2003), States supported and approved the new ICAO ATM Global Operational Concept, which encourages the implementation of a services management system which enables an operationally continuous regional airspace through the application of a series of ATM functions.

A.3 As per the guidance principles established by ICAO Council with regard to the facilitation of the inter-regional harmonization, the regional plans for CNS/ATM systems implementation in the regions should be prepared in accordance to the general profiles defined in the Global Air Navigation Plan for CNS/ATM Systems. After a careful analysis of the guidance principles of this Global Plan, GREPECAS adopted them and incorporated characteristics inherent to the CAR/SAM Regions, using as a basis the definitions of Homogeneous Areas and Main Traffic Flows. Homogeneous areas are those airspace portions with ATM requirements and similar complexity degrees, while main air traffic flows are airspaces where a significant amount of air traffic exists.

A.4 From the analysis carried out by ICAO/UNDP Project RLA/98/003, it may be inferred that while in general terms in the CAR/SAM Regions environment, currently no traffic congestions are registered requiring a complex flow management, they have been identified in some airports and airspace sectors, mainly in special periods and specific hours, where some congestions are already produced, which should be avoided.

A.5 In view of the above, GREPECAS considered that the early implementation of the ATFM shall ensure an optimum air traffic flow towards some areas or through them, during periods in which the demand exceeds or is foreseen to exceed the available capacity of the ATC system. Therefore, an ATFM system should reduce aircraft delays both in flight and ground and avoid system overloading. The ATFM system shall assist the ATC to comply with its objectives and achieve a more effective utilization of the airspace and airports available capacity. ATFM should also ensure that air operations safety is not compromised in case unacceptable levels of air traffic congestion occur and at the same time ensure that air traffic is effectively administered without applying unnecessary restrictions to flow.

A.6 The ATFM/TF/5 Meeting examined the draft ATFM Manual to be applied by the CAR/SAM Region FMU/FMP, which contained guidelines related with ATFM implementation, such as demand and capacity, traffic management tools, traffic Management initiatives (TMI), Communications and coordination, organization and structure, system performance measurement, collaborative decision-making, common ATFM terminology whose aim was to provide orientation in ATFM management.

A.7 The document was in its initial stage and the Meeting agreed that it would be convenient to continue with its development. Subsequently, a number of the States that participated in ATFM/TF/5 reviewed the document and brought the work forward to its current version.

C. **Purpose**

C.1 The purpose of this document shall be to assist the States/Territories of the CAR/SAM Region~~s~~ to establish a common understanding of the roles of each party interested in the effective provision of the flow management service, capacity to air traffic services, ~~and to~~ aircraft operators, and implementation of ATFM in CAR/SAM Region~~s~~.

Note: The intent of this document is to function as an introduction and not as an all inclusive body of knowledge. It is implied that this will be considered a living document that will be modified as needed to reflect the growth, future needs and harmonization of the CAR/SAM Regions.

D. **ATFM Implementation Strategy**

D.1 The operational concept establishes a simple implementation strategy. It is recommended that this strategy be developed in phases, so as to ensure maximum utilization of the available capacity and enable all concerned parties to obtain sufficient experience.

D.2 The experience acquired in other Regions and by some States in the SAM Region permits States/Territories and International Organizations to apply basic ATFM procedures in airports, without the immediate need for a Regional ATFM Center. A Regional ATFM Center shall demand ample studies to define operational concepts, requirements of systems and institutional aspects for ATFM implementation in the SAM Regions.

Note: For additional details, see Caribbean/South America Air Traffic Flow Management Operation (CAR/SAM ATFM CONOPS).

E. **Centralized ATFM strategy for CAR/SAM Regions**

E.1 GREPECAS/13 was of the opinion that two CAR and SAM scenarios should be taken into account, but that they could be modified insofar as the operational concept development and the implementation plans progress. The strategy is to develop a harmonized planning of a CAR and SAM interregional ATFM system.

E.2 In the future, in order to maximize terminal and regional efficiency, consideration should be given to the establishment of a Centralized ATFM facility(s) that would have oversight responsibility for providing ATFM service.

E.3 It was also considered necessary that the procedures during all the implementation process be developed in a harmonious manner among the ATFM units to avoid risking operational safety. This entails establishing a regional and interregional strategy to facilitate and harmonize all the implementation process.

F. ATFM Stages

F.1 Initially ATFM initiatives may only be required during certain periods when aerodromes and ATC sectors experience delays due to demand and capacity related issues. In order to maximize the use of all resources available in the regions, either from personnel, equipment, facilities and/or automated systems, the ATFM implementation process should be established, planned and developed in phases (airport and airspace), according to the following sequence.

Note: Doc 9854, Global Air Traffic Management Operation Concept defines the ATFM stages.

F.2 **Strategic Stage.** At the strategic stage, demand and capacity balancing will respond to the fluctuations in schedules and demands, seasonal changes of weather and major weather phenomena, and special traffic management events such as Carnival. This takes place seven days or more prior to the day of operation and includes research, planning and coordination activities. This phase consists of analyzing the evolution of the forecast demand and the identification of potential new problems and in evaluating possible solutions. The outputs of this phase are the capacity plan for the following year, the Route Allocation Plans and sets of other plans that can be activated as necessary during the next phases. Through collaborative decision making, assets will be optimized in order to maximize throughput, thus providing a basis for predictable scheduling.

Example: The ATFM service provider in anticipation of an event would gather statistical data and discuss this with stakeholders for the development of an action plan. This plan should take into consideration both scheduled and non-scheduled FPLs.

F.2.1 This could include a special traffic management event such as a sporting event, or a planned outage that would impact airport/airspace capacities. The integral part of the strategic phase is to mitigate impact as much as possible through advance planning.

F.3 **Pre-tactical Stage.**

F.3.1 Applied six days prior to the day of operation and includes revisiting the strategic phase. It analyses and decides the best way to manage the available capacity resources and the need for the adjustment of TMIs. For example, this may include demand and capacity balancing, evaluation of the current capabilities of the ATC service provider, airspace user and aerodrome operator assets.

F3.2 In the pre-tactical phase, you are required to revisit the strategic plan and make appropriate adjustments as needed based upon newly received/changed information.

F.4 **Tactical Stage.**

F.4.1 At the tactical stage, demand and capacity balancing will focus more closely on demand management to adjust imbalances. It will consider weather conditions, infrastructure status, resource allocations, and disruptions in schedules that would cause an imbalance. Through collaborative decision making, these actions will include dynamic adjustments to the organization of airspace to balance capacity, dynamic changes to the entry/exit times for aerodromes and airspace volumes, and adjustments to the schedules by users.

F.4.2 Tactical Stage includes making appropriate real time adjustments based upon unanticipated factors and informing stakeholders of these changes.

G. **Concepts for Consideration**

G.1 ATFM shall be established with a view to optimizing the use of available airspace and airport capacity, and to enhance air traffic flow management processes. It shall be based on transparency and efficiency, ensuring that capacity is provided in a flexible and timely manner, consistent with the guidelines issued by ICAO.

G.2 Implementation shall support cooperation between air navigation service providers, airport operators and airspace users and shall cover the following areas:

a. flight planning
b. use of available airspace capacity during all flight phases
c. Issuing guideline initiatives for the optimization for the flow of air traffic

G.3 Implementation shall seek to balance the financial benefits for stakeholders with the expected operational safety improvements by the relevant parties and operational and technical benefits, taking into account the requirements for ATM global interoperability.

G.4 ATFM shall apply within CAR/SAM States airspace and airports to:

a. all flights intended to operate or operating in accordance with instrument flight rules (IFR) or visual flight rules (VFR)

b. all phases of those flights.

G.5 The following operations shall be excluded from the implementation of the ATFM initiatives:

a) State aircraft (according to national regulations)
b) Emergency
c) priority
d) Ambulance flights
e) Humanitarian flights
f) Search and rescue missions
g) Transport of human organs

Note: For additional details, see Caribbean/South America Air Traffic Flow Management Operations (CAR/SAM ATFM CONOPS).

G.6 It shall be recognized that airspace and airports are resources shared by all user categories with fairness and transparency, taking into account the operational safety needs of States and the commitments of international organizations.

G.7 Air traffic flow management should be based on principles of partnership to meet ATM expectations, by means of collaborative decision-making between:

a. Central units for air traffic flow management (ATFMC)
b. Flow Management Units (FMU/FMP)
c. Airspace users – general aviation, air carriers, the military
d. Aerodrome community

G.8 Air navigation service providers and air operators should share data when coordination agreement has been established using software/systems such as SYNCHROMAX, SIGMA (Evolution of SYNCHROMAX), PROSAT, and TFMS (formerly ETMS).

G.9 ATFM shall apply to each of the following parties, or to anyone acting on their behalf who may be involved in air traffic flow management activities:

a. aircraft operators
b. air traffic service providers
c. units involved in airspace management
d. airport operators
e. the central unit entrusted by Member States with the provision of air traffic flow management services.

Chapter 1: Organization and structure

1.1 It is understood that each State and/or service provider will develop an organizational structure that will meet the needs of the aviation system community. These needs at a minimum should address management and supervision of the following:

a. Air Traffic Flow Management System
b. Coordination/exchange of information both internal and external
c. Provide line authority as to how decisions are implemented
d. Ensure that mission requirements are met

1.2 Each organization may establish a Line of Authority that will support the mission of ATFM. This may include the following positions of responsibilities:

a. Manager of Traffic Flow Management System
b. Flow management unit that provides oversight for a specific geographic region and/or facilities
c. Flow management positions that are responsible for the day-to-day activities of traffic flow management

Note: Please see Appendix A for an example of the Trinidad and Tobago Civil Aviation Authority Flow Diagram of Piarco Flow Management Unit

Flow Management Unit (FMU)

1.3 FMUs monitor and balance traffic flows within their areas of responsibility in accordance with traffic management directives. The FMU is delegated the authority to direct traffic flows and implement approved traffic management initiatives (TMIs) in conjunction with, or as directed by, the supervisory authority.

Personnel requirements for FMU/FMP ATFM

1.4 Personnel working in a Centralized ATFM function as well as regional FMU/FMP functions shall require standardized and recurrent training in order to keep pace with an ever changing and fluid environment. A detailed plan of ATFM training in advance shall ensure the optimization of personnel achieving operational efficiency in their respective FMUs/FMPs. This will allow them to successfully face the important changes in their operational environments and allow them to provide the highest achievable level of customer service.

1.5 FMP Duties may include:

a Create and distribute plan of action after consultation with designated facilities and customers
b. Gather all relevant information such as weather, delays, NAVAID/radar shutdowns, runway closures, TELCO outages, computer malfunctions, and procedural changes affecting air traffic facilities. This may be accomplished through various means available; e.g., teleconference, email, internet.
c. Analyze and distribute all data.

d. Record in a designated log a full description of all TMIs (e.g., ground delay programs, ground stops, miles-in-trail) which may include, but not limited to, start and stop times, facilities/operations affected, and justification.
e. Coordinate procedures with all stakeholders.
f. Create a structure for dissemination of information; e.g., ATFM webpage.
g. Conduct daily teleconferences as needed.
h. Monitor/review the flow management system, make adjustments where necessary, and cancel when no longer required.

Chapter 2: Demand, Capacity and Impact Analysis

Planning Process

2.1 In order to balance demand with capacity, it is necessary to determine the airport and airspace capacity. Once these capacities are established, steps can be taken to monitor and evaluate air traffic demand and implement measures (e.g., TMIs) for achieving equilibrium in the system.

2.2 The following example provides a general concept of the steps involved regarding ATFM pre-event planning/actions and post-event analysis. Please see Appendix B ATFM flow chart analysis.

a. Determine Capacities
Review/assess airport/ATC sector capacities for accuracy.
Note: See Guidelines for the Calculation of Airport and ATC Sectors for the CAR/SAM Regions.

b. Assess Demand
Determine what forecasted demand will be for a specified time frame, 15-minute period(s), hour(s), shift, etc.

c. Analyze and Compare
Analyze and compare demand and capacity levels and time frames where demand is projected to exceed declared capacity.

d. Tool/technology for the analysis process
Manual computation or automated methodologies such as SYNCHROMAX, TFMS, PROSAT can be used to facilitate the demand/capacity analysis process. (See Appendix D)

e. Communicate situational information
Communicate situational information to facilities/stakeholders via available means utilizing Collaborative Decision Making (CDM) methodology. (See Appendix E regarding a model for CDM structure).

f. Determine the action required to mitigate demand imbalance
After gathering information and soliciting input, determine appropriate TMI needed for situation.

g. Disseminate TMI information
Inform stakeholders of TMI planned to mitigate the situation. This can be accomplished via telephone and/or automation.

h. Monitor the situation
Examine the situation periodically in order to ensure the applied TMIs are mitigating the situation. If necessary, re-evaluate and make the appropriate adjustments.

i. Conduct post analysis of event
Afterwards, perform post-event analysis to determine the effectiveness of the TMIs and catalog best working practices.

Chapter 3: Traffic Management Initiatives (TMI)

3.1 TMIs are techniques used to manage air traffic demand according to system capacity. Some TMIs must be considered as control instructions or procedures. The determination is based on the size of the event, the coordination process, and the event duration.

Purpose

3.2 TMIs are important techniques for managing the air traffic system when they are coordinated and applied properly. TMIs are applicable when it is necessary to manage fluctuations in the air traffic demand, but they do cause an impact to the customers. It is important to consider this impact and implement only the initiatives that are necessary for maintaining the integrity of the system. Therefore, traffic management personnel should employ the least restrictive methods available in order to minimize delays.

Note: In certain instances it may be necessary to apply combinations of TMIs in order to maintain system integrity and still employ the least restrictive measures; e.g., miles-in-trail with holding in lieu of ground stopping aircraft.

3.3 **Types of TMIs**

Name	Description
a. Airborne holding	Holding of aircraft is a commonly utilized TMI especially when anticipated due to volume, weather, outages etc. When airborne holding is forecasted, AT facilities and customers can make appropriate adjustments and alert personnel as to the reasons and length of holding. Airborne holding is normally done when the operating environment supports holding and the conditions are expected to improve shortly; this ensures aircraft are available to fill the capacity at the airport.
b. Altitude	Utilized to segregate different flows of traffic, or to distribute the number of aircraft requesting access to a specified geographic region. **a. Capping**: Term to indicate aircraft will be cleared to an altitude lower than their requested altitude until they are clear of a particular airspace. Capping may apply to the initial segment of the flight or for the entire flight. **b. Tunneling**: Term to indicate traffic will be descended prior to the normal descent point at the arrival airport to remain clear of an airspace situation; e.g., holding. Capping and Tunneling are techniques commonly used to keep aircraft from entering busy and complex sectors and still permitting them to depart with minimal delays.
c. Fix balancing	Assigning an aircraft a fix other than that in the filed flight plan in the arrival or departure phase of flight to equitably distribute demand.

Name	Description
d. Ground delay programs (GDP)	A GDP is a TM process administered by the FMU; when aircraft are held on the ground in order to manage capacity and demand at a specific location, by assigning arrival slots. The purpose of the program is to support the TM mission and limit airborne holding. It is a flexible program and may be implemented in various forms depending upon the needs of the air traffic system.
e. Ground stops (GS)	GS is a process that requires aircraft that meet specific criteria to remain on the ground. Since this is one of the most restrictive methods of traffic management, alternative initiatives should be explored and implemented if appropriate. GSs should be used: I. In severely reduced capacity situations (below most user arrival minimums, airport/runway closed for snow removal, or aircraft accidents/incidents); II. To preclude extended periods of airborne holding; III. To preclude sector/center reaching near saturation levels or airport grid lock; IV. In the event a facility is unable or partially unable to provide ATC services due to unforeseen circumstances; and V. When routings are unavailable due to severe weather or catastrophic events.
f. Miles-in-trail (MIT)	The number of miles required between aircraft that meet a specific criteria. The criteria may be separation, airport, fix, altitude, sector, or route specific. MIT are used to apportion traffic into manageable flows, as well as to provide space for additional traffic (merging or departing) to enter the flow of traffic.
g. Minutes-in-trail (MINIT)	The number of minutes required between successive aircraft. It is normally used in a non-radar environment, or when transitioning to a non-radar environment, or when additional spacing is required due to aircraft deviating around weather.
h. Reroutes	Reroutes are ATC routings other than the filed flight plan. They are issued to: I. Ensure aircraft operate with the “flow” of traffic. II. Remain clear of special use airspace. III. Avoid congested airspace. IV. Avoid areas of known weather where aircraft are deviating or refusing to fly.

Name	Description
i. Sequencing programs	These programs are designed to achieve a specified interval between aircraft; they may be software generated or determined by ATFM personnel. Different types of programs accommodate different phases of flight. **1. Departure Sequencing Program (DSP) -** Assigns a departure time to achieve a constant flow of traffic over a common point. Normally, this involves departures from multiple airports. **2. En route Sequencing Program (ESP) -** Assigns a departure time that will facilitate integration in the en route stream. This is accomplished by instructing an air traffic control tower to call the traffic management unit for release **--** "Call For Release." **3. Arrival Sequencing Program (ASP)** - Assigns fix crossing times to aircraft destined to the same airport.

TMI approval authority

3.4 The designated FMU/FMP for each Service provider and/or State is the approval authority for all TMIs that impact their airports, TMAs, and en route airspace system.

TMI processing

3.5 Prior to implementation, the FMU/FMP responsible for ATFM oversight must identify the need for a TMI, examine alternative options, and develop a justification for the TMI. The FMP must be prepared to discuss and coordinate the proposed TMI with the receiving facility prior to implementation. FMPs must continuously monitor and evaluate the TMI and make the necessary adjustments, including cancellation and notification in a timely and effective manner.

Chapter 4: COLLABORATIVE DECISION MAKING PROCESS (CDM)

4. CDM

4.1 CDM has evolved into a philosophy or a collaborative approach of how to conduct business. It brings together operators, government, private industry, military, and academia, for the purpose of improving ATFM decision making through enhanced information exchange, data sharing, and improved automated decision support tools.

4.2 As the aviation community continues to evolve, States and/or service providers will be required to keep pace with increasing demand levels, expanding capacities, and technological advances. As a result of these challenges, a new sense of partnership will be required by all stakeholders who either directly or indirectly contribute to the overall well being and success of the aviation industry.

4.3 This new partnership will combine the talents and experiences of all individuals which will facilitate the harmonization and globalization of the world's airspace system.

4.4 Collaborative decision making (CDM) is a methodology that brings service providers and system stakeholders together for the purpose of improving air traffic flow management decisions.

4.5 CDM is a key element to maximizing airport and air operations because it considers all coordination elements between air navigation service providers such as flow management units (FMUs) and recipients of these services such as aircraft and airport operators. CDM includes stakeholders participating in the planning process by sharing information such as aircraft position, predictions, weather forecast, traffic forecast, and in general anything that would contribute to the efficient operation of a regional air space system.

CDM Objectives

4.6 The CDM concept seeks to improve air traffic flow and airport capacity management by reducing delays and foreseeing events through improved resource management.

4.7 These objectives include but are not limited to:

a. Providing up-to-date information in real time to all stakeholders, thus ensuring a more accurate prediction of events and better capacity utilization, supported by a collaborative decision-making process.

b. Transferring information for decision-making between stakeholders.

c. Requiring that all system stakeholders function in an equitable manner for the betterment of the system.

d. Exchanging information among the relevant parties in charge of aircraft flight planning and operations to increase system capacity, and thus improving:

1. Operations quality and stability
2. Offering reliability and predictability
3. traffic synchronization amongst stakeholders
4. And air space organization which is critical for maximizing capacity and enhancing system safety.

4.8 CDM participants should consider utilizing all available electronic means and tools that allow the analysis of various traffic scenarios in order to more effectively achieve the balancing of demand and capacity.

Note: Global experience has shown that teleconferences and electronic information exchanges are the recommended mechanisms for active participation throughout the System. However, each State/Service Provider may utilize whatever means are available to foster the sharing of information.

4.9 CDM implementation allows system participants to optimize their decisions in collaboration with others, by learning about their preferences, constraints, and the real and foreseen situation.

4.10 Decision-making within the CDM framework is facilitated by the exchange of accurate and timely information, aiming to adjust procedures, mechanisms and tools for better system performance.

4.11 The CDM concept consists of the following basic elements:

a. Information exchange.
b. Weather conditions.
c. Sequencing before departure.
d. Adverse conditions.
e. Up-to-date flight information.
f. Flight scheduling.
g. Airport Master Plan.
h. General Contingency Plans.
i. State aircraft operation planning (military, law enforcement and other).

CDM Structure

4.12 Developing a CDM organization within each State and/or Service Provider is essential in order to achieve the benefits that this model offers. The flexibility is that it takes into consideration any communication venues that already exist, and does not require expending valuable resources, and can be tailored to meet the local regional needs as determined.

4.13 For example, Service Providers can begin with engaging the stakeholders as follows:

a. Scheduling regular (e.g., quarterly, monthly, weekly) meetings
b. Pre-establishing agenda items that are of mutual concern
c. Discussing how tactical decisions will be managed, shared, and disseminated
d. Establishing CDM participants and entering a memorandum of understanding (MOU) which stipulates guidelines in areas such as information distribution, rules and regulations, and how shared leadership is accomplished.
e. Developing sub-work groups which fall under the direct leadership and guidance of the CDM organization and are specifically tasked with developing solutions.

Conclusions

4.14 As with any collaborative endeavor, each participant should realize that this will require a level of sacrifice, commitment and a sense of what is best for the greater whole and/or system.

4.15 Participant must be willing to share:
a. Responsibility
b. Resources
c. Accountability
d. Mutual goals
e. Mutual trust

4.16 And as a direct result of these efforts, participants can generally expect to realize:

a. More effective communications
b. Increased information exchange
c. More effective decision making
d. Better solutions to ATFM problems

4.17 It is well accepted that regardless of the technological advances made in the aviation industry, CDM will require a culture change, team work approach, and be an integral part of how the future is shaped.

Chapter 5: Coordination

Coordination of traffic management information.

5.1 It is understood that there exists different levels of traffic flow management oversight within the SAM regions. The concept is for each Service Provider to assign responsibility within their respective FIR for collecting, disseminating, monitoring, and providing oversight of TMIs. This methodology would ensure that applicable information is shared by all Service Providers and customers in a timely and efficient manner.

5.2 Examples of applicable information include: Tactical level information such as capacities, demand, imbalances, airport conditions and anything that would impact their respective system. This list is not all inclusive and will depend on the good judgment of each facility.

5.3 A typical traffic management hierarchy model may consist of the following:

a. Control towers (TWR) coordinate with Approach Control Facilities (APP).
b. Approach Control Facilities (APP) coordinate with an Air Control Center (ACC).
c. Air Control Centers coordinate with ATFM authority.
d. ATFM authority would be responsible for dissemination within their respective region.

Note 1: The purpose of this coordination methodology is to establish a protocol for each level of the organization to be informed of timely and accurate information. It is fully realized that this as an organizational model and can be modified to meet the needs of each specific situation.

Note 2: For standardization, it is desirable that the States develop and/or modify letters of agreement (LOA) which describe this coordination.

Exchanging ATFM Information

5.4 Air Traffic Service (ATS) and/or ATFM Service Providers in adjacent FIRs should establish schedules and regular telephone conferences, as required, to meet their specific operational needs. The purpose of these conferences is to share and disseminate information to air traffic facilities and customers for making tactical adjustments as required.

5.5 It is recommended that the following three methods be utilized:

a). Scheduled telephone conferences. These consist of a pre-coordinated time when FMUs establish a conference amongst themselves to exchange information.

b). Tactical telephone conferences. These are non-scheduled teleconferences which are conducted on a real-time tactical level to make adjustments.

c). Automated Web Pages. ATFM service providers may create web pages with relevant ATFM information, as described in this paragraph. The purpose of the web pages is to share applicable system information for everyone to access and to minimize workload. As a minimum, the web pages may include:

i. TMI's such as ground stops, delay programs, etc.
ii. Runway configuration
iii. Runway/airport capacities
iv. Weather
v. Outages
vi. Delay information
vii. Airport closures
viii. Miscellaneous

Operations plan

5.6 The operations plan may take into consideration the terms of balancing demand and capacity, ATFM initiatives, special operation requirements, special events (such as Carnival, World Cup) and any other events that may arise. The purpose is to tactically and/or strategically develop an outlook for the applicable airspace system that the aviation community can use as a planning forecast. Specific items that may be used are similar to the web page and allow the aviation community to provide input into the development of this plan. For example, an FMU would canvass applicable Air Traffic facilities and customers on how best to resolve system impacts.

5.7 Special operations may be defined as air operations conducted by State aircraft or for humanitarian activities. It is implied that each State and/or service provider may define special operations as needed.

Implementing, adjusting, coordinating, and canceling of TMIs.

5.8 It is recommended that States and/or service providers develop an internal operations manual for their respective facilities describing the above-mentioned actions. For example:

a. Implementing TMIs could be accomplished through established means such as telephone calls, web pages, or any other available method.

b. Constant monitoring would be required for making the appropriate adjustments.

c. Cancellation of TMI's would be required when no longer needed or when system balance is achieved regarding demand and capacity related issues. It is important for all system users to be informed of canceled initiatives so that adjustments can be accomplished.

Civil/military Coordination

5.9 It is recommended that States and/or service providers develop a letter of agreement (LOA) with their military customers that describes how military special use airspace can be utilized when not in use and/or during peak civilian periods in order to increase efficiency.

Chapter 6: Common ATFM Message Terminology

General

6.1 The primary goal of these guidelines is to develop standard terminology and phraseology for the exchange of ATFM telephone messages. The information contained herein is intended to reflect the current use of plain language and provide a basis for harmonization.

6.2 This includes the concept of modular and structured ATFM messages and define the components as who, what, where, when and why.

6.3 This is important because, at present, there is no module regarding how ATFM restrictions should be achieved by Service Providers. As with any communication model, it is the responsibility of both parties (sender and receiver) to ensure that the message is understood correctly and can be applied as requested.

6.4 It should be recognized that once information is exchanged regarding a restriction, it is considered MANDATORY unless otherwise coordinated.

ATFM Message Components

6.5 Each message should have five components that contain plain language elements and when combined provide a complete ATFM message.

6.6 This section breaks down the five message components.

a. WHO: This identifies the parties involved. Who is transmitting and receiving the message.
Examples: CGNA THIS IS COLOMBIA FMU

CCFMEX THIS IS ATCSCC

b. WHAT: This identifies the objective to be achieved.
Examples: REQUEST 30 MILES IN TRAIL

REQUEST 5 MINUTES IN TRAIL

c. WHERE: This identifies the location of the ATFM objective to be achieved. It is often preceded by a modifying clause, indicating what aircraft or traffic the restriction will apply to. The modifying clause and the location combination are used to construct the "where" component.
Examples: FOR ALL AIRCRAFT LANDING EL DORADO INTERNATIONAL AIRPORT
FOR ALL TRAFFIC LANDING HOUSTON INTERCONTINENTAL AIRPORT

d. WHEN: This identifies the time and/or duration of the ATFM objective to be achieved.
Examples: FROM NOW UNTIL 1700 UTC
FROM 2000 UTC TO 2130 UTC

e. **WHY**: This identifies the reason for the ATFM objective:

Examples: DUE TO SEVERE WEATHER OVER
EL DORADO INTERNATIONAL AIRPORT

DUE TO A LONG-RANGE RADAR OUTAGE

6.7 The following is an example of a complete message:

CGNA this is Colombia FMU. REQUEST 30 MILES IN TRAIL FOR ALL AIRCRAFT LANDING EL DORADO INTERNATIONAL AIRPORT FROM NOW UNTIL 1700 UTC DUE TO SEVERE WEATHER OVER EL DORADO INTERNATIONAL AIRPORT

Amendment

6.8 The amendment of an ATFM message should include similar elements but with additional modifiers. These modifiers may include:

a. CHANGE
b. AMEND
c. REDUCE
d. INCREASE
e. DECREASE

Example: Guayaquil FMP this is Lima FMP, reduce your miles-in-trail to Jorge Chavez International Airport from 30 miles-in-trail to 20 miles-in-trail from 1400 UTC to 1700 UTC due to improving weather conditions at Jorge Chavez International Airport.

Cancellation

6.9 The cancellation of an ATFM message should contain a canceling word or phrase. It is normally not necessary to state the reason for the cancellation. A canceling word or phrase may include:

a. CANCEL
b. RESUME
c. RESUME NORMAL
d. RELEASE

Example: Caracas FMP this is Georgetown FMP, cancel the ground stop for Timehri Cheddi Jagan International Airport due to the runway now open.

6.10 Cancellation messages should also identify which message is being cancelled because several restrictions could be in place at one time.

EXPLANATION OF TERMS

6.11 The development of this document is based on the understanding of important terms and expressions that are described below:

Stakeholders involved in ATFM - The ATFM stakeholder community includes the organizations, bodies or entities which could participate, collaborate and cooperate in the planning, development, utilization, regulation, operation, and maintenance of ATFM system. Among them are:

***Aerodrome Community* -** The air traffic control authorities, aerodrome authorities, commercial, military, and general aviation operators, and other parties involved in the provision and operation of the physical infrastructure needed to support the take-off, landing, and ground handling of aircraft.

***Airspace Providers* -** Refers, in general terms, to Contracting States/Territories in their capacity as airspace owners with the legal authority to permit or deny access to their sovereign airspace. The term may also be applied to organizations of the State assigned responsibility for establishing the standards and guidelines for use of the airspace.

***Airspace users* -** Refers to the commercial, military, and general aviation operators that utilize the sovereign airspace of States/Territories/Organizations.

***ATM service providers* -** All of the organizations and personnel (e.g., controllers, engineers, technicians) involved in the provision of ATFM services to airspace users.

***Military aviation* -** Refers to the personnel, aircraft, and equipment of military organizations that serve a vital role in the security of States/Territories.

***International Civil Aviation Organization (ICAO)* -** Considered the only international organization in position to efficiently coordinate the implementation activities of global ATM.

Air Traffic Flow Management (ATFM) - A service established with the objective of contributing to a safe, orderly and expeditious flow of air traffic by ensuring that ATC capacity is utilized to the maximum extent possible and that the traffic volume is compatible with the capacities declared by the appropriate ATC authority.

Air Traffic Management (ATM) - A service which comprises airspace management, air traffic flow management, and air traffic services.

ATM Community - All the organizations, bodies or entities which might participate, collaborate and cooperate in the planning, development, use, regulation, operation and maintenance of the ATM System.

Air Traffic Management System - A system which provides ATM through the integration and cooperation of personnel, information, technology, facilities and services. It also involves the support of on-board and space-based communications, navigation and surveillance.

Air Traffic Volume - The number of aircraft within a defined airspace or aerodrome movement area in a given period of time.

Capacity (for ATFM purposes) - The maximum number of aircraft that can be accommodated in a defined airspace or aerodrome (throughput) in given period of time.

Declared Capacity (for ATFM purposes) – A measure of the ability of the ATC system or any of its subsystems or operating position to provide service to aircraft during normal activities. It is expressed as the number of aircraft entering a specified portion of airspace in a given period of time taking into account weather, ATC unit configuration, staff and equipment available, and any other factors that may affect the workload of the controller responsible for the airspace.

Regional ATFM Center - A flow management unit responsible for the provision of air traffic flow management across multiple area control centers.

Collaborative Decision Making - an operating philosophy and the associated technologies that enable traffic managers and aviation industry representatives to respond in a timely manner to constraints in the airspace system.

Demand - The number of aircraft requesting to use the ATC system in a given time period.

Efficiency - The ratio of the cost of ideal flight to the cost of procedurally constrained flight.

Flow Management Unit (FMU) - FMUs monitor and balance traffic flows within their areas of responsibility in accordance with traffic management directives. The FMU is delegated the authority to direct traffic flows and implement approved TMIs in conjunction with, or as directed by the oversight authority.

Flow Management Position (FMP) - A position established in an appropriate air traffic control unit to ensure the necessary interface between the local ATFM functions and other FMUs and/or a centralized ATFM unit.

Homogeneous ATM area - An airspace with a common ATM interest, based on similar characteristics of traffic density, complexity, air navigation system infrastructure requirements and other specified considerations, wherein a common detailed plan will foster the implementation of ATFM.

Main Traffic Flow - The concentration of a significant volume of air traffic on the same, or similar, flight trajectories.

Routing area - An area that encompasses one or more major traffic flows, defined for the purpose of developing a detailed plan for the implementation of ATM systems and procedures.

Traffic Management Initiatives - Techniques used by traffic managers to balance air traffic demand with available capacity.

6.12 ACRONYMS

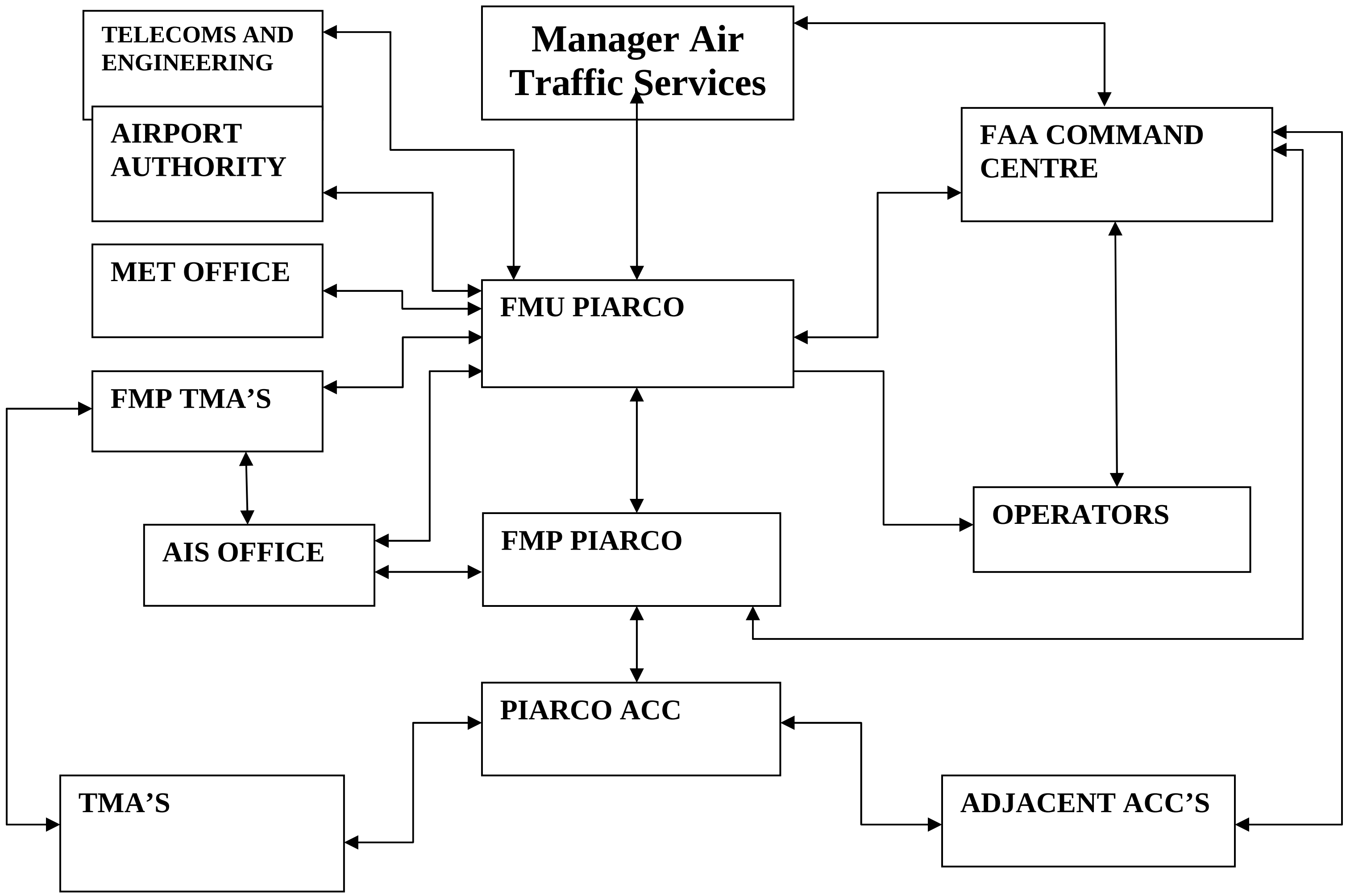
ACC	Centro de control de área	Area control centre
AFTN	Red de telecomunicaciones fijas aeronáuticas	Aeronautical fixed telecommunication network
AIP	Publicación de Información aeronáutica	Aeronautical information publication
AIS	Servicio de información aeronáutica	Aeronautical information service
ANP	Plan de navegación aérea	Air navigation plan
ANS	Servicios de navegación aérea	Air navigation services
ANSP	Proveedor de servicios de navegación aérea	Air navigation service provider
AO	Explotador de aeronave	Aircraft operator
APP	Oficina de control de aproximación	Approach control facility
AAR	Régimen de aceptación del aeropuerto	Airport Acceptance Rate
ADR	Régimen de salida del aeropuerto	Airport Departure Rate
ATC	Control de tránsito aéreo	Air traffic control
ATFM	Gestión de afluencia del tránsito aéreo	Air traffic flow management
ATM	Gestión del tránsito aéreo	Air traffic management
ATS	Servicios de tránsito aéreo	Air traffic services
CAA	Administración de aviación civil	Civil aviation authority
CAR/SAM	Regiones Caribe y Sudamérica	Caribbean and South American Regions
CATFM	Dependencia central de gestión de afluencia del tránsito aéreo	Centralised air traffic flow management unit
C/BA	Análisis de costo-beneficio	Cost/benefit analysis
CDM	Toma de decisiones en colaboración	Collaborative Decision Making
CNS/ATM	Comunicaciones, navegación y vigilancia/gestión del tránsito aéreo	Communications, navigation, and surveillance/air traffic management
CTA	Area de control	Control area
FDPS	Sistema de procesamiento de datos de vuelo	Flight data processing system
FIR	Región de información de vuelo	Flight information Region
FMP	Puesto de gestión de afluencia	Flow management position
FMU	Dependencia de gestión de afluencia	Flow management unit
FPL	Plan de vuelo	Flight plan
GREPECAS	Grupo regional CAR/SAM de planificación y ejecución	CAR/SAM regional planning and implementation group
IATA	Asociación del Transporte Aéreo	International Air Transport

	Internacional	Association
IFALPA	Federación Internacional de Asociaciones de Pilotos de Línea Aérea	International Federation of Air Line Pilots' Associations
IFATCA	Federación Internacional de Asociaciones de Controladores de Tránsito Aéreo	International Federation of Air Traffic Controllers' Associations
LOA	Carta de acuerdo	Letter of Agreement
MET	Servicios meteorológicos para la navegación aérea	Meteorological services for air navigation
NOTAM	Aviso a los aviadores	Notice to airmen
OACI/ICAO	Organización de Aviación Civil Internacional	International Civil Aviation Organization
PANS ATM	Procedimientos para los servicios de navegación aérea – Gestión de tránsito aéreo	Procedures for Air Navigation Services –Air traffic management
PIRG	Grupo regional de planificación y ejecución	Regional planning and implementation group
PROSAT	Pronóstico de saturación	PROSAT
RNAV	Navegación de área/Area Navigation - RNAV Route: Ruta de navegación de área	Area navigation route
RNP	Performance de navegación requerida	Required navigation performance
SID	Salida normalizada por instrumentos	Standard instrument departure
STAR	Llegada normalizada por instrumentos	Standard instrument arrival
SYNCHROMAX	SYNCHROMAX	SYNCHROMAX
TBD	A ser determinado	To be determined
TELCON	Tele-conferencia	Telephone conference
TFMS	Sistema de gestión de la afluencia del tránsito (previamente, ETMS)	Traffic Flow Management System (previously called ETMS)
TMA	Área de control terminal	Terminal control area
TMC	Coordinador de la gestión del tránsito	Traffic Management Coordinator
TMI	Iniciativa de gestión del tránsito	Traffic management initiative
TWR	Torre de control	Control tower
WSO	Oficina del Servicio Meteorológico	Weather Service Office
WWW	Red mundial	World Wide Web

Appendix A

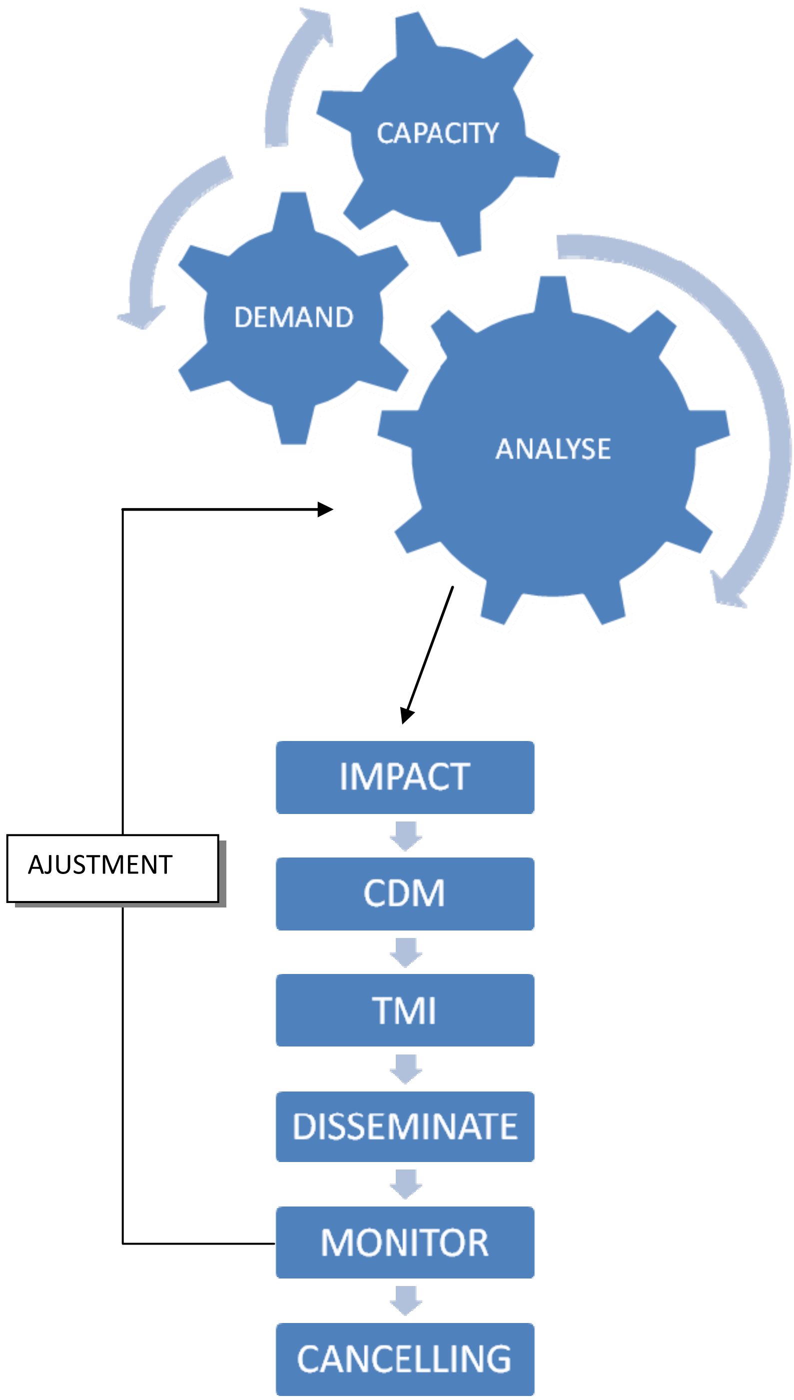
Trinidad and Tobago Civil Aviation Authority

Flow Diagram of Piarco Flow Management Unit



Appendix B

FLOW CHART ATFM ANALYSES

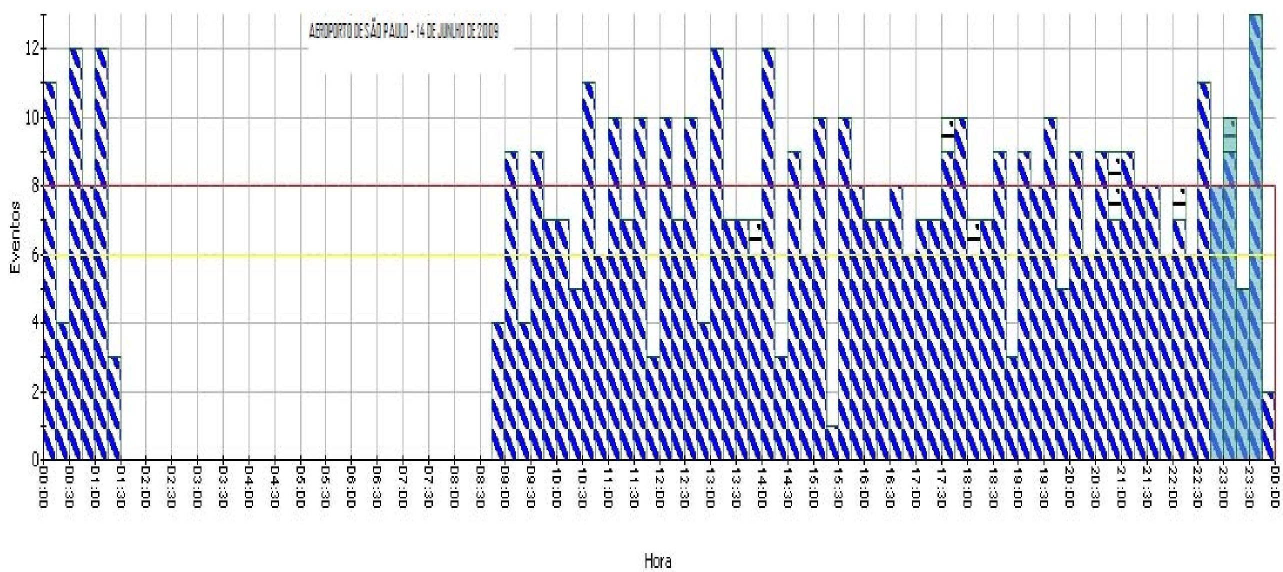


Appendix C

The following attachments depict examples of ATFM tools currently being used:

a. SYNCHROMAX
b. PROSAT
c. TFMS

SYNCROMAX DEMAND AND CAPACITY ANALYSE



PROSAT

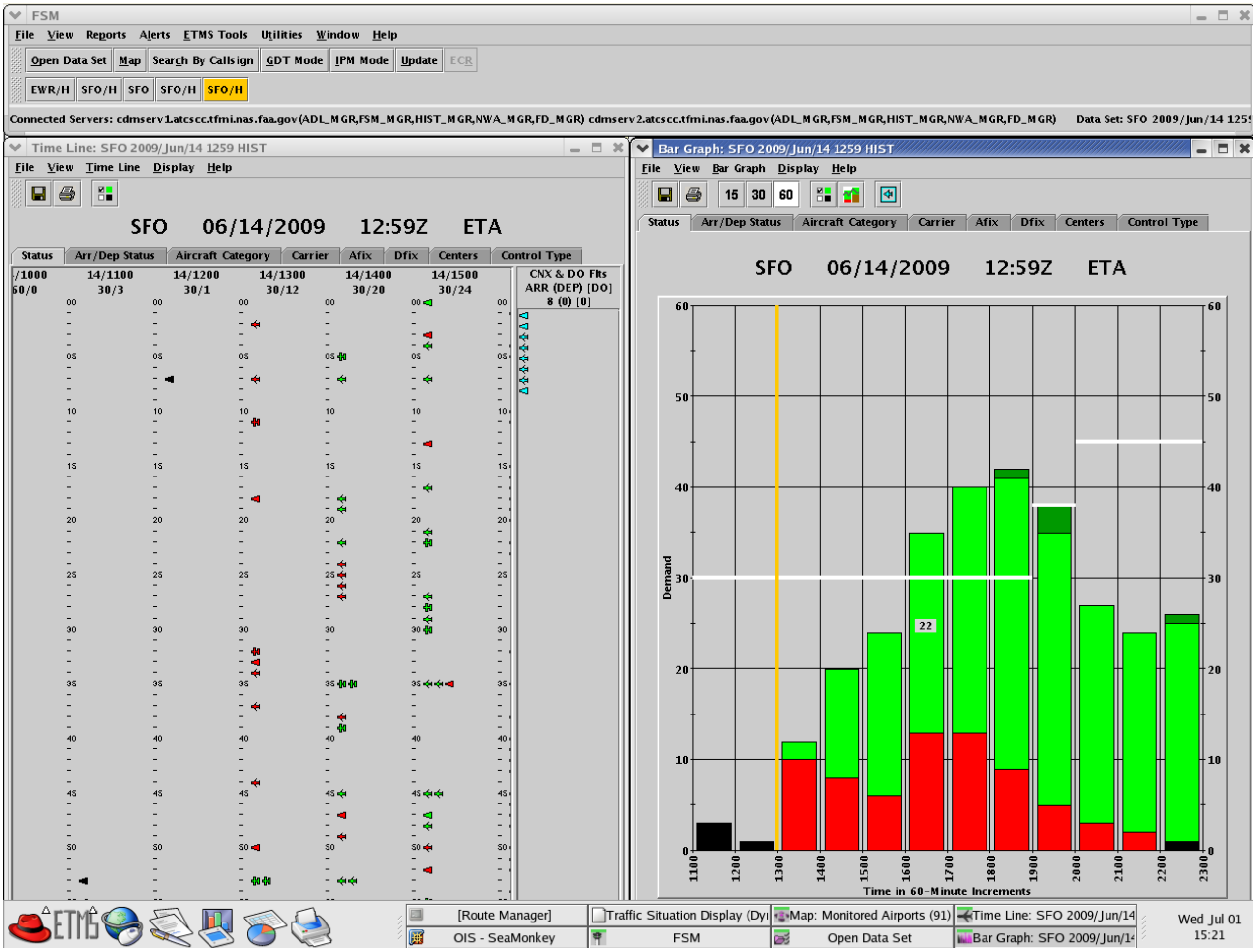
- **PRO**nóstico de **SAT**uración
  - Saturation Forecast

- Integral software in use at CCFMEX since February 2002. It provides a forecast up to four hours in advance of possible air traffic congestion at México City RTCU.

- It is capable to receive and process any ATS messages in addition to particular ones (FLU, SSL) in order to calculate ETA to the designated airport.

  - México City (MMMX)

TFMS



FSM
File View Reports Alerts ETMS Tools Utilities Window Help
Open Data Set Map Search By Callsign GDT Mode IPM Mode Update ECR
EWR/H SFO/H SFO SFO/H SFO/H
Time Line: SFO 2009/Jun/14 1259 HIST
SFO 06/14/2009 12:59Z ETA
Status Arr/Dep Status Aircraft Category Carrier Afix Dfix Centers Control Type
CNX & DO Flts ARR (DEP) [DO] 8 (0) [0]
Bar Graph: SFO 2009/Jun/14 1259 HIST
File View Bar Graph Display Help
SFO 06/14/2009 12:59Z ETA
Demand
Time in 60-Minute Increments
Wed Jul 01 15:21

Appendix D

INTERNATIONAL OPERATIONS
PLANNING TELCON FORMAT

_____ Greeting and introduction

xxxxZ planning telcon, working from advisory xxx
Covering the timeframe from xxxx UTC to xxxx UTC

_____ Common Weather Products – working from

1) the ICAO Area "A" Prog Chart, valid xxxx UTC for (Date)
2) the ICAO Area "A" IR Satellite photo, xxxx UTC for (Date)

_____ Planning discussion -- Work from south to north then from the Caribbean to the Pacific (east to west)

Significant weather and atmospheric conditions

- Thunderstorm activity
- Turbulence
- Volcanic ash clouds

Terminal discussion

For select aerodromes:

- Airport/Sector Capacities
- Projected terminal demand
- Aerodrome constraints, such as construction projects or NAVAID outages

Anticipated traffic management initiatives (TMIs)

- Expanded miles-in-trail
- Potential airborne holding
- Potential ground stops

Enroute discussion

- Enroute constraints, such as frequency outages or NAVAID outages
- Route discussion and issues
- Anticipated TMIs
  - Expanded miles-in-trail
  - Potential airborne holding

_____ Additions to the plan, including any pertinent tactical updates.

_____ Stakeholder input, comments, and questions

_____ Next International Planning Telcon: xxxxZ

APPENDIX B

Sample Size for the Combined Sectors 9 and 10 of FIR Curitiba

The minimum sample size for the number of ATCO to be listened and the number of aircraft observations for each ATCO for obtaining η is determined using the simple random sampling technique for finite population considering 5% of sampling error tolerance and 95% of level of confidence, according to the following formula:

(a1)

$$n = \frac{Z^2_{\alpha/2}.p.q.N}{\varepsilon^2.(N-1) + Z^2_{\alpha/2}.p.q}$$

Where:

n = sample length;

$Z_{\alpha/2}$ = level of confidence (for 95% $Z_{\alpha/2}$ = 1,96);

p = percentage of elements that belongs to the interested category;

q = percentage of elements that doesn't belong to the interested category (q=1-p);

N = size of the population; and

ε = sampling error tolerance (5%).

- **Number of ATC to be listened**

In order to obtain the minimum number of ATCO to have a sample that give us 95% of confidence and 5% of error tolerance in the measurements, we consider p as the probability of an ATCO to be on his position in one given day and in one given period of work. If a day has x periods of work (x=4), therefore p is given by dividing x by the total number of ATCO of the ACC Curitiba (population size N=130) and multiplied by the number of sectors of FIR Curitiba (10 sectors):

$$p = \frac{x}{N} \bullet number\ of\ setors = \frac{4}{130} \bullet 10 = 0{,}31$$

(a2)

With formulas (a1) and (a2) the minimum necessary number of ATCO is defined in 94. As all ATCO works in all positions in ACC Curitiba, the minimum number 94 of ATCO can be divided by the 10 existing sectors, which means, **in each sector shall be collected data from at least 9 ATCO.**

- **Number of aircraft to be observed per ATCO**

In order to obtain the minimum number of aircraft to have a sample that give us 95% of confidence and 5% of error tolerance in the measurements of η, we estimate the size of the aircraft population for the sectors of interest (N=43 aircraft for the formula (a1)) as the maximum number of airccraft in a peak day and in a peak hour.

As it is not possible to estimate *p* for this case, we can consider *p* = 0,5.

With formula (a1), N=43 and *p*=0,5, **the minimum necessary number of aircraft is defined in 39.**

In order to know at least how many aircraft shall be observed per ATCO, the number of aircraft is divided by the number of ATCO, both mentioned above, as follows:

$$n = \frac{number\ of\ aircraft}{number\ of\ ATCO} = \frac{39}{9} \cong 5\ * \qquad \text{(a3)}$$

* round up.

With formula (a3), **the minimum necessary number of aircraft per ATCO is defined in 5.**

The minimum sample size for the number of observations per ATCO for the average time of communication (τm) is determined using the simple random sampling technique for infinite population considering 5% of sampling error tolerance and 95% of level of confidence, according to the following formula:

$$n = \left(\frac{Z_{\alpha/2} . \sigma}{\varepsilon} \right)^2 \qquad \text{(a4)}$$

where:

n = sample length;

$Z_{\alpha/2}$ = level of confidence (for 95% $Z_{\alpha/2}$ = 1,96);

σ = standard deviation (obtained from a pilot sample, σ =11,72s in 122 measurements); and

ε = sampling error tolerance (5%).

The pilot sample was taken from recorded ATC communication of March 16th. 2009, a typical day. The overall audio time was 60 minues in the peak hour from 22:58 to 23:58 UTC.

From formula a3 and the above mentioned parameters, it follows:

$$n = \left(\frac{Z_{\alpha/2}.S}{\varepsilon} \right)^2 = \left(\frac{1{,}96.11{,}72}{5} \right)^2 = 21{,}105 \tag{a4}$$

As the obtained number of observations per ATCO for the average time of communication (τm) is bellow 30, this number must be increased to be equal to **30 observations per ATCO.**

APPENDIX C

GUIDE FOR THE APPLICATION OF A COMMON METODOLOGY TO ESTIMATE AIRPORT AND ATC SECTOR CAPACITY FOR THE SAM REGION.

Regional Project: ICAO RLA/06/901

Lima, Peru, 6 to 17 July 2009

Version 1.0

Roberto Arca Jaurena

TABLE OF CONTENTS

Attachments

I. Purpose

The purpose of this document is to provide SAM States with a guide on how to apply a common methodology to calculate airport and ATC sector capacity, thus allowing ATM planners to develop plans, if necessary, to improve such capacity in order to meet present or future demands of the system.

II. Introduction

Annex 11 to the ICAO Convention, in paragraph 3.7.5.1, establishes that air traffic flow management (ATFM) will be implemented in airspaces where air traffic demand at times exceeds, or is expected to exceed, the declared capacity of the air traffic control services concerned, and paragraph 3.7.5.2 contains a Recommendation to implement ATFM through regional air navigation agreements or, if appropriate, through multilateral agreements, and that such agreements must make provision for common procedures and methods for determining capacity.

This same Annex 11 defines "*declared capacity*" as the measure of the ability of the ATC system or any of its subsystems or operating positions to provide service to aircraft during normal activities. It is expressed as the number of aircraft entering a specific portion of airspace in a given period of time, taking due account of weather, ATC unit configuration, available staff and equipment, and any other factor that may affect the workload of the controller responsible for the airspace.

Additionally, Document 4444, ATM, Procedures for Air Navigation Services, in paragraph 3.1.4.1 of Chapter 3, establishes that the appropriate ATS authority should periodically review ATS capacity in relation to traffic demand; and should provide for flexible use of airspace in order to improve efficiency operational efficiency and increase capacity.

Next, paragraph 3.1.4.2 states that, in the event that traffic demand regularly exceeds ATC capacity, resulting in continuous and frequent traffic delays, or it becomes apparent that traffic demand forecasts will exceed capacity values, the appropriate ATS authority should, to the extent possible, take steps to maximise the use of existing system capacity; and develop plans to increase capacity in order to meet current or foreseen demand.

GREPECAS determined that air traffic flow management (ATFM) implementation will help ensure optimum air traffic flow and will help reduce ground and airborne delays, thus avoiding an overload of the air traffic system. This is accomplished by balancing demand and system capacity, with a view to maintaining a safe, orderly and expeditious traffic flow. Accordingly, GREPECAS approved the CAR/SAM ATFM Operational Concept (CAR/SAM ATFM CONOPS), which reflects the expected order of events and should assist and guide planners in the design and gradual implementation of an ATFM system.

Through Conclusion 14/149, GREPECAS adopted the ATFM CONOPS and requested States to establish a work programme for the implementation of the ATFM CONOPS.

In this sense, a SAM ATFM implementation group was established within the scope of Project RLA/06/901, charged with taking action for the implementation of ATFM in the region.

With the sponsorship of Regional Technical Cooperation Project RLA 06/901 *Assistance for the implementation of a regional ATM system based on the ATM operational concept and the corresponding technological support for communications, navigation, and surveillance (CNS)*, a course on Airport and ATC Sector Capacity Calculation was held in March 2009, at the CGNA facilities in Rio, Brazil, in order to start standardising the training of ATM planners of the SAM States on this matter.

III. General

In order to understand this document, we believe it is necessary to highlight some general considerations related to the purpose of this document, which, as a guide to the States, contributes to the achievement of ATFM goals.

The purpose of ATFM is to achieve a balance between air traffic demand and system capacity to ensure an optimum and efficient use of system airspace. This is achieved by balancing demand and the capacity declared by the appropriate air traffic service providers in order to accommodate a maximum number of flights under a gate-to-gate concept.

In order to manage this demand-capacity balance, it is necessary to know the current and expected demand, to establish a capacity baseline using an analytical calculation, to analyse the impact that expected demand will have on existing capacity, to identify the limitations of, and possible improvements to, the current system based on a cost/benefit analysis thereof, to set priorities, and to develop a capacity improvement plan.

Airspace Capacity

Airspace capacity is not unlimited but it can be more or less optimised depending on many factors, such as airspace design and flexibility; ATC system capacity; number of sectors and their complexity; segregated airspace; availability, training, and response capability of personnel; available CNS infrastructure; degree of automation; and even the equipage and type of aircraft in the fleet.

When analysing airspace capacity, we are interested in focusing on ATC system capacity and, in this sense, we have highlighted some concepts that must be taken into account as indicators to calculate the ATC sector capacity, such as: workload, the importance of observable and non-observable tasks performed by air traffic controllers. We also present some models used to measure and assess the parameters employed to determine capacity in order to meet air traffic demand.

Airport Capacity

Many different parameters are used for measuring airport and airspace capacity. Consequently, care must be taken when defining the scope of each capacity in order to better understand the indicators to be used for assessing each capacity.

This document defines airport capacity as the maximum number of airport operations in a given aerodrome under specified conditions (*e.g.,* aerodrome layout, aircraft mix, weather conditions, facilities, aircraft parking, etc.), taking into account all take-off and landing operations during a specified period of time (hour, day, month, year, season).

It may occur that the physical capacity of the aircraft parking platform, the number of aircraft defining airport capacity in a given aerodrome, is less than the number of aircraft resulting from estimating the runway capacity for that given aerodrome; in such case, this would be the real constraint for that airport.

When all of the requirements agreed upon are duly met, service capacity is 100%. This capacity is reduced when such requirements have operational limitations; the greater the constraint in resources, the lower the service capacity. But the declaration of a percentage lower than the actual capacity may also be taken into account in order to manage contingencies or any other type of unforeseen operation.

The Workload Concept

It is necessary to analyse the impact that controller “workload” has on the measurement of ATC capacity in a given airspace sector, and to identify the techniques necessary to calculate traffic management in an automated system by using models.

Attempts have been made at measuring workload by assigning a value to the various tasks (task load) performed by the controller.

Consideration should also be given to the extensive studies on, and approaches to, workload that take into account human factors, where situational awareness, error detection and system monitoring, teamwork, trust and proper training, human error, etc., are fundamental aspects to be taken into account.

When analysing capacity it is important to consider the nature of the tasks that make up the workload, since there are tasks that can be observed and quantified, while others cannot be observed and, hence, are not so easy to quantify.

Nevertheless, it is possible to establish some constant values for these non-quantifiable tasks based on statistical analyses and, thus, factor them in the methodology used in some models.

DORATASK Model

A model widely used for task assessment and workload analysis is the DORATASK model. This is an analytical model based on fast-time simulation that provides clear examples and logical calculations. This model was first used by the United Kingdom Operational Research and Analysis Bureau to estimate ATC sector capacity (DORA Interim Report 8818), for terminal sectors (DORA Interim Report 8916) and to calibrate a simulated model for two route sectors of the London ACC (DORA Report 8927).

In this model, workload is calculated by adding up the time it takes the controller to perform all the necessary tasks, both observable and non-observable, associated with air traffic flow in his/her sector and working position. Sector capacity is determined by adding the total task load to a parameter that indicates the amount of time needed for controller recovery.

Observable tasks are routine tasks performed by the controller, such as those applicable to all aircraft, irrespective of how many aircraft are under his/her control (*e.g.*, standard communications), and those tasks aimed at solving conflicts when an aircraft is facing an actual or potential conflict.

Non-observable tasks are the planning tasks carried out by the controller and the mental tasks required to detect or forecast conflicts. But it is important to note that some tasks cannot be observed in procedural systems, but can be observed and quantified in automated systems (*e.g.*, planning, conflict forecasting). Although planning is a non-observable task--with the aforementioned caveats--, the DORATASK Model contains algorithms that estimate workload, which is the time the controller spends on planning tasks. These estimates and examples are based on statistical data that provide constant values used to adjust analytical formulae.

In the case of terminal area capacity calculations, the DORATASK Model identifies two non-observable tasks, initial processing and radar monitoring. These tasks are modelled using the number of radar displays and the combination of pairs of aircraft that must be checked. Since these tasks are, by definition, linear and quadratic with respect to the number of aircraft, each of these measures is multiplied by an unknown number (constant value) that is estimated by each analyst after comparing with sectors of known capacity.

The DORATASK Model has served as the basis for many other capacity calculation applications and models, taking into account controller workload. However, it is not the only model to be taken into account since, as noted, it has some limitations. Nevertheless, this model is quite suitable for ATC sector capacity studies and, with the appropriate modifications, can be adjusted to automated systems.

IV. Methodological Models for Estimating Capacity in the Region

ATC Sector Capacity Calculation Model used in Brazil

In Brazil, ACC capacity is estimated by analysing the capacity of its sectors, which is analytically obtained using the methodology established in ICA 100-30, ATC Staff Planning (DECEA, 2007).

Currently, the estimated sector capacity value can be considered to be the maximum number of aircraft that each air traffic controller (ATCO) can control simultaneously in a given sector, thus providing the capacity applied by the ATC unit.

The Airspace Control Department (DECEA) uses a methodology to determine the APP and ACC sector capacity, which provides a sector capacity reference value.

This methodology consists in obtaining a value based on a mathematical formula. The basic data for such formula are derived from an investigation carried out by a special working group at the ATC unit, taking into account a busy period in which controller actions and availability to manage control sector traffic are observed and timed; this provides a data sample to be used in the ATC sector capacity calculation methodology.

The ATC Sector Capacity Calculation Model used in Brazil appears in **Attachment 1** to this Document.

Data sampling for estimating ATC sector capacity

It is important for data collection to be significant so as to dilute temporary stochastic deviations and to represent reliable values for the ATC unit.

In Brazil, the method used to determine sector capacity takes into account the load borne by an ATCO in performing his/her tasks, and is based on the assessment of the tasks performed by the controller at times of high traffic volume, as seen in the DORATASK model.

According to the current model, controller workload is the summation of times spent on:

1. communication (transmission/reception);
2. manual activities (filling out flight progress strips) and coordination; and
3. traffic planning and distribution.

The Brazilian methodology applies the controller "availability factor" (ϕ) concept, which is defined as the percentage of time available for the ATCO to plan aircraft separation procedures.

This availability factor normally falls between a minimum value of 40% of ATCO time for non-radar control, and 60% for radar control (ICA 100-30). It is thus clear that efforts need to focus on increasing the "availability factor" ϕ.

The latter can only be achieved by applying measures to reduce the level of controller intervention in the activities mentioned in 1 and 2.

The percentage accounted for by this ϕ factor could increase if the "Man/Machine Interface –MMI" is enhanced; that is, when increasing the level of automation in some tasks.

Studies conducted by Brazilian experts, who analysed the sampling techniques, show that it is advisable to make at least 30 observations of each parameter for each controller, during peak traffic, respecting the minimum number of controllers specified by the sampling technique used.

It is essential to collect as many observations and controllers as possible in the unit being assessed in order to eliminate extreme values and to minimise any type of trend (*e.g.*, cases of controllers or pilots who are either too slow or too quick in their communications, affecting the arithmetical mean).

A detailed and analytical explanation of the sampling technique used in Brazil to determine the number of observations required by sector and by controller is given in **Attachment 2** to this document. The form used in Brazil to assess ATC communications load is shown in **Attachment 3** to this document.

The form used by Brazil to assess the "availability factor" appears in **Attachment 4** to this document.

<u>FAA ATC sector capacity calculation model for global event in Trinidad y Tobago</u>

On occasion of the 20th Meeting of Eastern Caribbean Directors of Civil Aviation (20th E/CAR/DCA) held in Miami, Florida, United States, on 4-7 December 2006, the FAA presented a model to determine ATC sector capacity based on the experience gained in this field by the United States, in order to support ATFM-related activities during the Cricket World Cup held in Trinidad and Tobago.

This is a case of macroscopic calculation that includes an additional factor, which is a constant value to account for human factors, calculated by the FAA to measure the average time spent by a controller interacting with an aircraft.

Since we believe this could be very useful for a State that needs to apply a simple, safe, macroscopic methodology to face a specific event in which a greater-than-normal demand is expected, we have included this study as **Attachment 5** to this document.

V. <u>Airport Capacity Calculation Models</u>

<u>Airport capacity calculation model applied in Brazil</u>

In Brazil, the runway capacity calculation method assumes a take-off operation between two consecutive landings, maintaining the regulatory separation minima defined in ICA 100-12 (Rules of the Air and Air Traffic Services). Runway capacity is estimated for a 60-minute interval in function of average runway occupancy times.

In order to determine the capacity of the set of runways, the following factors are taken into account:

a) Planning factors; and
b) Factors related to landing and take-off operations.

<u>Planning factors</u> are elements used to simplify the mathematical models or the operational aspects that bear on the determination of runway capacity. The most commonly used are:

a) Ideal air traffic sequencing and coordination conditions;

b) All personnel is considered to have the same training and same operational performance;

c) All navaids and visual aids are considered to be technically and operationally unrestricted; and

d) All (VHF/telephony) communication equipment considered operational is operating normally.

Regarding factors related to landing and take-off operations, the following can be identified:

a) Average runway occupancy times;

b) Aircraft mix;

c) Percentage of threshold utilisation;

d) Length of the final approach segment;

e) Regulatory aircraft separation minima applied;

f) Runway and taxiway layout; and

g) Final approach speed.

The main parameters used to estimate runway capacity in Brazil are listed below:

- Aircraft mix (aircraft category and approach speed)
- Average runway occupancy time (sec.)
- Separation criteria adopted by the ATC

Aircraft mix is defined as the percentage distribution of the aircraft fleet operating at the aerodrome according to aircraft categories. The aircraft mix for aerodromes must be estimated based on the total daily movement, a constant value in IEPV 100-34 (Movement of Aircraft at Aerodromes) or in the SGTC, which is determined using the arithmetical average of a sample containing data for a period of at least one week.

According to Doc 8168, aircraft are subdivided into five categories, depending on threshold speed, which must be 130% of the value of the stall speed in the landing configuration (full flaps, gear down). Accordingly, aircraft are classified as follows:

CAT "A" speed less than 90 kt

CAT "B" Speed between 91/120kt

CAT "C" Speed between 121/140kt

CAT "D" speed between 141/165kt

CAT "E" Speed between 166/210kt

The average runway occupancy time is the weighted arithmetical mean of runway occupation times, by aircraft category, where the aircraft mix operating in the aerodrome is the weighting factor.

This method is based on data collection, which, for the sake of greater precision, should be done at peak hour, since air traffic flow is more fluid during such period, thus reducing runway occupancy time. If data collected does not cover all categories, additional data may be gathered at other times and even on different days. Runway occupancy time during take-off shall be counted from the time the aircraft leaves the holding position up until it crosses the opposite threshold.

The separation criteria adopted by the ATC vary in light of the regulations in force on this matter in each State. For purposes of this study, Brazil has considered a separation of 5 NM, which coincides with the outer marker (OM) and the runway threshold.

If there is no OM, a point is determined in the final approach that has a known distance and that determines the impossibility for another aircraft from entering the runway while the aircraft that is about to land is flying over this point or is between this point and the runway threshold concerned.

The methodological steps and data collection forms to estimate the physical, theoretical, and declared runway capacity are described in **Attachment 6** to this document.

FAA Runway Capacity Calculation Model

The model used by the FAA to estimate capacity and analyse delays at airports is described in Advisory Circular (AC) 150/5060-5, Change 1 and 2, entitled “Airport Capacity and Delay”.

This Circular contains calculations to determine airport capacity, annual volume of operations, and aircraft delays. It also contains a special calculation to determine capacity when it is affected by poor weather, airports with no radar coverage or without ILS, as well as detailed analyses to assess airports with parallel runways, and more refined calculations in order to analyse special situations that may affect runway capacity.

In this Model, the hourly capacity is influenced by runway configuration, aircraft mix, percentage of arrivals, percentage of go-around operations under visual flight rules (VFR), and location of taxiway exits. Hourly capacity is estimated for both VFR and instrument flight rules (IFR) conditions. Weather is a determining factor for this calculation method.

Furthermore, this Model is based on a large number of statistical data collected for many years, providing for very good performance in American scenarios in terms of theoretical and actual capacity.

Attachment 7 to this document provides detailed information on the procedure used by the FAA to calculate the potential and actual airport acceptance rate (AAR). Advisory Circular (AC) 150/5060-5, Change 1 and 2, "Airport Capacity and Delay", can be found at the following web site:

http://www.airweb.faa.gov/Regulatory_and_Guidance_Library/rgAdvisoryCircular.nsf/ACNumber/641E65B7EA1DC3B685256D0C006289F6?OpenDocument

Runway Capacity Calculation Model used in Colombia

In order to determine the El Dorado airport capacity, the ATM Procedures Group of the UAEAC of Colombia applied Advisory Circular (AC) 150/5060-5, Change 2, entitled "Airport Capacity and Delay", to assess runway capacity of the El Dorado airport.

This method was derived from the calculation models used by the FAA to determine airport capacity. It was necessary to compare the theoretical calculations with the operational reality of the airport; theoretical values were similar to those obtained in practice.

Information regarding the methodology applied in Columbia to calculate airport acceptance and concerning an analysis carried out at El Dorado airport appears in **Attachment 8** to this document.

VI. Capacity Improvement

The demand/capacity analysis identifies a number of factors that are extremely important for the efficient planning of the ATM system so as to ensure an optimum balance that will benefit the ATFM. **Attachment 9** provides some guidelines for ATM planners to improve system capacity.

Regarding the planning process for demand, capacity, and delay analysis, we recommend that the CAR/SAM ATFM Manual be used. This manual is available in the ICAO South American Office web site.

VII. Conclusion

Knowledge of the capacity of air traffic sectors or ATC operating positions is necessary for two main reasons. The first is that, for long-term planning, it is necessary to anticipate efficiently any reduction of future capacity, as inferred from traffic forecasts. The second reason is that if there is already a reduction in capacity that calls for flow control, it must be known in order to restrict traffic without overloading the system or excessively affecting operators, or in order to implement best practices on operational performance.

There are many methods for calculating capacity and, as readily noted from the different models described in this Guide, air traffic controller workload is a significant parameter in these models. Therefore, a better knowledge of workload factors and their implications will provide for a more suitable operational adjustment of the services provided to meet the demand.

It is also essential to have a perfect understanding of the variables attributed to the mathematical model, using for the calculation the number of aircraft that can be served in ATC sectors and airport capacity in a given period of time.

To this end, a critical study and an impartial and detailed analysis of the reality of each State in relation to the results obtained in the data survey are necessary in order to quantify such variables, allowing planners to identify operational limitations of the services provided duly in advance.

On the other hand, the observation of occasional factors, such as communication deficiencies, adverse weather, preferential aircraft operations, military operations, aircraft in emergency, among many others that may cause operational delays, can have a negative impact on results and lead to conclusions that do not reflect reality if not properly weighted.

Likewise, information about the number of aircraft simultaneously controlled by a single controller in a given sector must be collected by rated teams knowledgeable of the characteristics of the place to be assessed, preferably air traffic controllers. Data collection frequency and the amount of data to be collected by sector and by controller should be such as to include cases of air traffic flow modification, sectoring, installation/failure of navigation infrastructure, new design for airspace optimisation, etc.

Concerning the data obtained from capacity calculations, they are not only useful for identifying system limitations or behaviour, but also are extremely important for defining the number of ATCOs required in a given ATC service.

Staff sizing should consider the number of persons required to cover all operating positions in the event of maximum configuration. The analysis conducted to create a control sector is based on a significant and constant increase of traffic in that sector. Traffic flow history and evolution are also used to forecast the need for, and size of, HARDWARE and human resources required for a given period of time.

The right number of operational air traffic control positions to face peak periods can be defined by correctly analysing and interpreting demand/capacity data, or reducing the numbers on certain schedules.

The capacity calculation models studied for purposes of this guide do not fully cover the many variables that should be taken into account, especially for quantifying non-observable tasks, where only long-term analysis of statistical data can support the use of a constant value in the mathematical formulation or the comparison with a reference system that has been tested in practice.

Hence, we note, for example, that some of the constant values used in the FAA system result from substantial statistical information gathered throughout many years, thus providing a high level of certainty. However, it may be concluded that this constant value has an additional factor inherent to the system from where data were collected, which is supplemented with very serious studies on human factors.

Regarding the above, it should be noted that, for different reasons, personnel performance measurements can vary significantly depending on the organisational culture involved, personnel recruitment levels, the number of staff available, training levels, and many other factors that cause this performance to have an impact on the human factor constant value.

The model applied in Brazil is quite complete since it applies a modern airport capacity approach, and is also very accurate in quantifying ATC sector capacity. However, as with other models, it assumes ideal conditions and it would be convenient to quantify a standard adjustment for each State when such conditions are not met in a given system, so as to reduce the acceptance number or the capacity in the formula.

Nevertheless, by applying best practices in airspace design, sequencing, coordination, and CNS maintenance; and by applying regulatory separation minima, and rigorously recruiting and training human resources, a State can raise the standard and optimise the mathematical formulation of the model applied, thus increasing capacity significantly.

Furthermore, the optimisation of the existing runway and taxiway configuration, the aircraft mix, the average runway occupancy times, the length of the final approach segment specified as safety distance, fleet capacity and equipage, and crew training are other factors that contribute to capacity optimisation and that must be considered when declaring the capacity of an ATC sector or of an airport.

As for the models applied in the region, no major differences in the results obtained for airport acceptance rates are found between the FAA model and the model used in Brazil for purposes of determining runway capacity. If we analyse the various ATC sector capacity calculation models, we will note that, to a greater or lesser extent, the main parameters are derived from the DORATASK Model.

With few exceptions, as we have seen, most of the States in the Region have little practical experience in the use of a model for calculating capacity. This has an impact on the size of the available database that could be used to adjust constant values in each of the different operational scenarios in the systems of the Region, unlike the FAA, whose databases have been fed with data collected for many years and are constantly updated.

Notwithstanding the above, experts from most of the States in the Region attended the Course on Airport and ATC Sector Capacity Calculation, held in March 2009, at the CGNA facilities in Rio, Brazil, under ICAO Project RLA/06/901, to receive training on the application of the model used in Brazil; this represents a very valuable capital that can be tapped.

Recommendation

In order to take maximum advantage of the training provided under ICAO Project RLA/06/901, and taking into account that such training provides a standard calculation criterion for the region that can be used in a first phase as an initial common methodology to calculate the airport and ATC sector capacity, we recommend that SAM States use the Methodology to Calculate Airport and ATC Sector Capacity applied in Brazil.

We recommend this methodology for the following reasons:

a) standard training for experts from the States participating in the Project;

b) use of a model that is applicable to both airport and ATC sector capacity;

c) low cost methodology that does not require any software;

d) it does not require constant values derived from databases that some States do not have available yet;

e) practical experience on the use of the model can be acquired immediately, resulting in:

- ✓ the creation of a standard database for statistical purposes,
- ✓ the evaluation of model weaknesses,
- ✓ feedback to improve the model,
- ✓ more experience gained in order to decide on the future application of a definitive common model for the SAM Region in a second phase;

f) according to the planned regional ATFM implementation level, it is possible to leave for a near future the selection of a single definitive capacity calculation model to be used in the Region, as recommended by ICAO Annex 11, and

g) it supplements the use of some methodologies applied in the Region (*e.g.,* Colombia) and, basically, is not in conflict with the airport acceptance rate calculation system used in Colombia in this first phase.

In summary, this guide serves as a basis to define the parameters and indicators to be taken into account for analysing delays, to identify best practices leading to increased capacity, and to detect the differences and similarities of the models used in the Region, thus creating a sound baseline so that in a near future, in a second phase, it may be possible to apply a common, optimised airport and ATC airspace sector capacity calculation model for the Region, enriched with the experience gained in this initial regional implementation.

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ATTACHMENT 1 TO APPENDIX C

ATC Sector Capacity Calculation Model Used in Brazil

In Brazil, the number of aircraft that can be controlled simultaneously by a single controller (N) in a given sector is estimated using the following formula (ICA 100-30):

$$N = \phi \cdot \delta \cdot (\eta \cdot \tau_m \cdot \nu_m)^{-1} \tag{1}$$

where ATC capacity is a direct or inverse function of some factors (ICA 100-30) to be considered:

Factors directly proportional to ATC capacity:

ϕ : the controller availability factor, defined as the percentage of time available for planning aircraft separation procedures;

δ : average distance flown by aircraft in the sector, which is a function of the paths and en route or terminal procedures established for each sector;

Factors inversely proportional to ATC capacity:

η : number of communications for each aircraft in the sector, which must be limited to the least possible number required for an understanding between the pilot and the controller. This number can be minimised by issuing a complete clearance sufficiently in advance for flight planning;

τ_m : mean duration of each message. This factor can be minimised by issuing messages objectively, without long explanations that are detrimental for an understanding between the pilot and the controller; and

ν_m : mean speed of aircraft in the sector.

If δ and ν_m are replaced with the average flight time of the aircraft in the sector (T), this formula can be replaced with a simpler version:

$$\mathbf{N = \phi \cdot T \cdot (\eta \cdot \tau_m)^{-1}} \tag{2}$$

The values of factors ϕ, T, η and τ_m are empirically obtained following the standard procedures (DECEA, 2007).

For example, we can consider T= 12 minutes, τ_m = 9 seconds, ϕ = 60%, η= 6, which gives a number of aircraft N = 8 simultaneously controlled by the controller in the given sector. In other words, in this sector and under these conditions, a controller would simultaneously control 8 aircraft.

There are several factors that are constantly influencing the number N and that are directly related, such as the size of the sector or route modification. Consequently, whenever a significant change is observed, the value obtained must be updated.

Under ideal conditions, data collection must be done with busy traffic. Therefore, the selection of the ideal period is a factor to be taken into account, since it has a direct impact on the final result.

ATTACHMENT 2 TO APPENDIX C

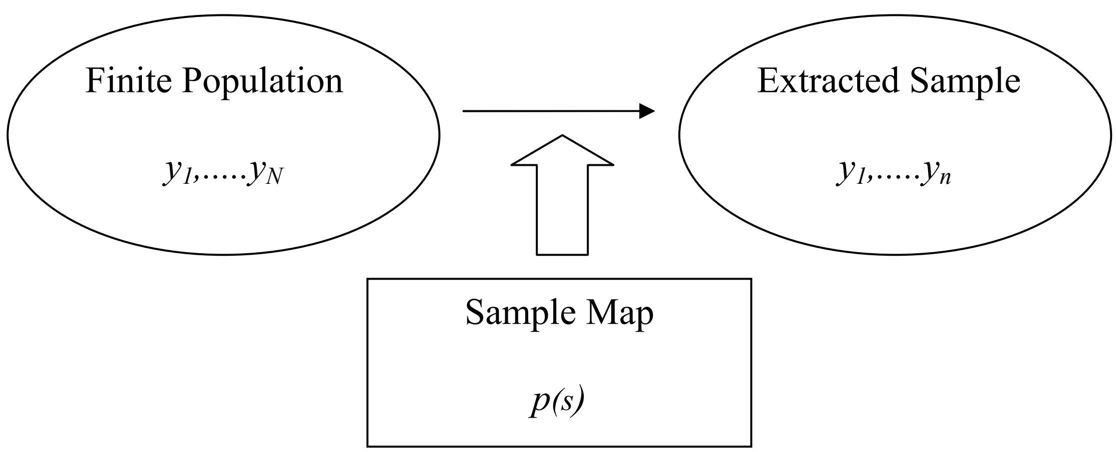
1. Sampling Technique to Estimate ATC Sector Capacity

1.1. In order to obtain information about aircraft population, and knowing that the investigation of all fleet elements is very costly--even though the population is finite--, a sample needs to be taken. The process of choosing the elements that belong to a sample is called sampling. The main idea is to draw a portion of the population (sample) that is representative and that allows investigators to make assertions and draw conclusions. For these considerations to be valid, sample selection must be random and probabilistic.

1.2. For a sample to be considered probabilistic, it must be drawn from a finite population, that is, $U=\{1,...,N\}$. Based on a finite population, a sample s = $\{i_1,...,i_N\}$ is selected and attributed a selection probability designated by *p(s)*. The way in which the selection process is carried out is known as the sampling plan or sample design. This process determines a well-defined set of all possible samples, designated by *S,* and also assumes that the selection probability of each sample *p(s)* is known or can be calculated.

1.3. With regard to the population, some assumptions must be established: each of its elements ($i \in U$) has a non-nil selection probability and the variable values of interest in the population under investigation $y_1,...,y_N$ shall be considered fixed and unknown (VIEIRA, 2001). Maintaining generality, it is also possible to re-index the population so that the selected sample may be represented by the indices $s=\{1,..,n\}$. VIEIRA (2001) points out that a sample $s \in S$ is selected using a random mechanism so that it is selected with a probability *p(s).* Figure 1 describes this procedure:

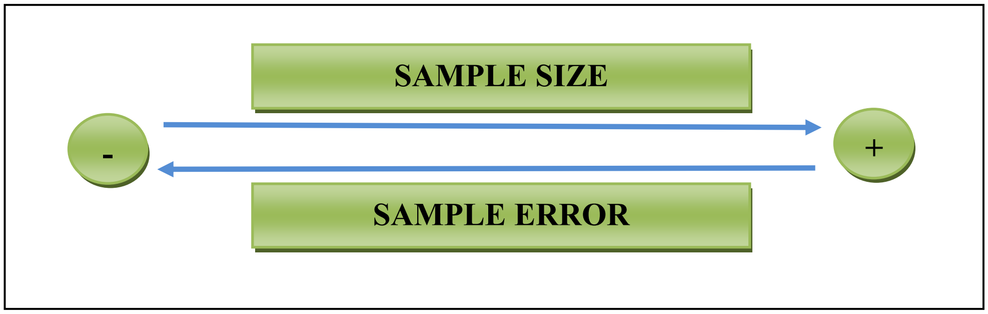
Figure 1 – Random or Probabilistic Sample



Pessoa e Nascimento Silva (1998, p.20)

1.4. The results obtained from an investigation based on samples are not rigorously exact with respect to the universe. These results present a measurement error called sample error (ε). We cannot prevent this sample error from happening; however, its value can be limited by selecting a sample of the right size. Obviously, the sample error and the sample size go in different directions (figure 2). The larger the sample, the smaller the error and *vice versa*.

Figure 2 – Intuitive relationship between sample size and sample error



1.5. Normally, an error estimate of 3% to 5% is used. In this context, population parameters are estimated providing for their error margin estimation (PESSOA; NASCIMENTO SILVA, 1998). The sampling techniques used by the CGNA to measure SISCEAB ATC sector capacity are simple random sampling for an infinite population and simple random sampling of a finite population. These techniques were selected so as to respect the criteria set forth in ICA 100-30, which contains the mathematical model used to determine the number of aircraft that an air traffic controller can simultaneously at any given time.

2. Simple Random Sampling for an Infinite Population

2.1 In order to arrive at sample sizes that are compatible with the reliability level and the desirable sample error, the CGNA uses a formula (1) to determine the sample size of the parameters of the mathematical model used to estimate ATC sector capacity. Since it is not possible to determine with precision the population size of these parameters, the infinite population technique is used.

$$n = \left(\frac{Z_{\alpha/2} . \sigma}{\varepsilon} \right)^2 \qquad \textbf{(1)}$$

Where:

n = Sample size;

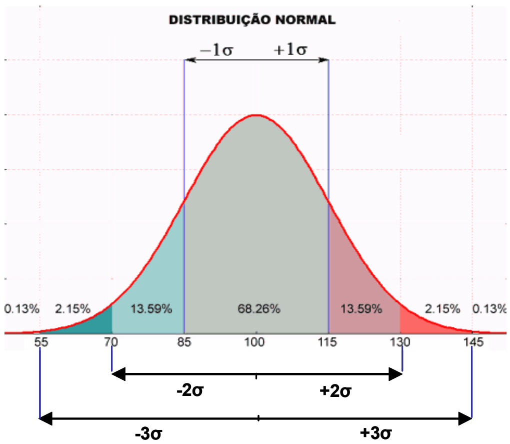
$Z_{\alpha/2}$ = Reliability level selected (95%), expressed by $Z_{\alpha/2}$ = 1,96;

σ = Population standard deviation; and

ε = Maximum error allowed.

2.2 The reliability level of the sample refers to the area of the normal curve that is defined based on the standard deviations from the average, as illustrated in figure 3:

Figure 3: Normal Distribution



1 standard deviation = 68,3% representative;

2 standard deviations = 95,5% representative;

and

3 standard deviations = 99,7% representative.

2.3 The most commonly used reliability values and the corresponding Z values are shown in table 1.

Table 1: Critical Values related to the reliability of the sample

Reliability Level	At	Critical Value $Z_{\alpha/2}$
90%	0,10	1,645
95%	0,05	1,96
99%	0,01	2,575

The reliability level adopted for the study is 95% reliability and the maximum error allowed is 5%.

2.4 Since σ is an unknown population parameter, we can use a preliminary value obtained from a pilot study, thus starting the sampling process. Based on a first data collection of at least 30 observations, the standard deviation of sample *S* is estimated and used instead of σ.

2.5 Excessively small samples may lead to unreliable results. Any result obtained from the formula involving a sample size of less than 30 must be increased to 30, since it is based on the use of the normal distribution.

3. Simple Random Sample for Finite Population

3.1 In order to determine the minimum number of controllers to be observed in each unit, the most suitable sampling technique is simple random sampling for finite populations. The formula below is used to determine sample size:

$$n = \frac{Z^2_{\alpha/2}.p.q.N}{\varepsilon^2.(N-1)+Z^2_{\alpha/2}.p.q} \qquad (2)$$

Where:
n = Sample size;
$Z_{\alpha/2}$ = Reliability level selected (95%), expressed by $Z_{\alpha/2}$ = 1,96;
p = Proportion of individuals in the population that belong to the interest group;
q = Proportion of individuals in the population that **do not** belong to the interest group (q=1-p);
N = Population size; and
ε = Maximum error allowed.

Also, in this case, if the value of n is less than 30, it shall be increased to 30.

3.2 In the study, p is equal to the probability of a controller being observed on a given day; in other words, a day has x work shifts, hence the probability of a controller being observed in any of the shifts is x divided by the total number of controllers multiplied by the number of sectors, as shown in the formula below:

$$p = \frac{x}{N} \bullet numberof\ \sec tors \qquad (3)$$

4. Sampling Technique used in Sectors 02 and 09 of the Curitiba FIR

4.1 According to ICA 100-30, the mathematical model for estimating the number of aircraft simultaneously controlled by a single controller in a given ATC sector is expressed by the following formula (4):

$$N = \frac{f.T}{n.tm} \qquad (4)$$

Where:
N = number of aircraft controlled simultaneously by one controller;
f = controller availability factor, as a percentage;
T = average time flown by the aircraft in the sector;
n = average number of communications of each aircraft in the sector; and
tm = average duration of each message, in seconds.

4.2 In order to obtain sample sizes that are compatible with the reliability level and sample error desired, formula (1) will be used to determine the sample size of the parameters of the mathematical model used to calculate ATC sector capacity, and formula (2) will be used to determine the minimum number of controllers to be considered for timing operations.

4.3 The necessary data were collected from audiotape recordings of VHF communications in ACC-CW sectors 02 and 09, on 16 March 2009. This day was chosen because the team had prior knowledge that it was a peak day compared to the rest of the year. The total audiotape time was 125 minutes and accounts in the following schedules: from 10:29 to 11:14 UTC and 11:14 to 12:14 UTC (sector 02), and from 22:58 to 23:25 UTC and 23:25 to 23:58 UTC (sector 09). These schedules were chosen because they had the highest air traffic flow (peak traffic).

4.4 Formula (1) was used to calculate the sampling, considering 95% reliability and a sample error of 5%. The data collected from the recordings provided the sample standard deviation (*S)* of parameter *tm* (average duration of each message, in seconds) equal to 12,31 (sector 02) and 11,72 (sector 09), from 137 and 122 measurements, respectively. Plotting these data in formula (1), we arrive at the following result:

Sector 02

$$n = \left(\frac{Z_{\alpha/2}.S}{\varepsilon}\right)^2 = \left(\frac{1{,}96.12{,}31}{5}\right)^2 = 23{,}299 \qquad (5)$$

Sector 09

$$n = \left(\frac{Z_{\alpha/2}.S}{\varepsilon}\right)^2 = \left(\frac{1{,}96.11{,}72}{5}\right)^2 = 21{,}105 \qquad (6)$$

4.5 As already mentioned, any value obtained from the formula that is below 30 must be increased to 30. Hence, the minimum number of repetitions to measure *tm* shall be at least 30.

4.6 The calculation of the minimum number of controllers to be considered for the timing shall account for the operational peculiarities of each ACC. In the case of ACC CW, the centre was deemed to have around 130 controllers working 4 shifts per day and capable of taking over positions in any of the 10 sectors. Based on this information and formula (3), the following is obtained:

$$p = \frac{4}{N} \bullet number\ of\ sectors = \frac{4}{130} \bullet 10 = 0{,}31 = 31\% \qquad (7)$$

4.7 Considering 95% reliability, 5% tolerance, N equal to 130 and p equal to 0,31, using formula (2), we obtain the following result:

$$n = \frac{Z_{\alpha/2}^{2}.p.q.N}{\varepsilon^{2}.(N-1)+Z_{\alpha/2}^{2}.p.q} = \frac{1{,}96^{2} \cdot 0{,}31 \cdot 0{,}69 \cdot 130}{0{,}05^{2} \cdot (130-1) + 1{,}96^{2} \cdot 0{,}31 \cdot 0{,}69} = 94\ ATCOs \qquad (8)$$

4.8 The big size of the sample compared to the population (72%) is justified because the total size of the population is considered small. The smaller the size of the population, the closer the value of the sample size to that value. Nevertheless, this sample could be diluted given the number of ATC sectors. In the case of the ACC CW, the 94 controllers selected may be distributed among the 10 existing sectors; in other words, at least 9 controllers shall be observed in each sector.

4.9 It should be noted that sampling techniques reveal **minimum** values of relevant samples. Therefore, as long as it is possible to collect more samples, based on available time and money, we recommend gathering a larger number of samples. As already stated, the bigger the sample, the more accurate the study.

4.10 In this study, parameter T (average flying time of an aircraft in the sector) was generated by the SINCROMAX system in Brazil and parameter f was calculated based on previous studies. In the studies to be carried out in the ACCs, these parameters shall be measured on site in order to have an exact measure of what is really happening.

4.11 With the simple random sampling technique for infinite populations, we reach the conclusion that the minimum number of observations to obtain parameters n and tm in ACC CW sectors 2 and 9/10 is 30 observations per controller during peak traffic.

4.12 With the simple random sampling technique for finite populations, we reach the conclusion that the minimum number of controllers to be considered for time tracking is 94 ATCOs. This number can be distributed among the 10 existing sectors of ACC CW; hence the minimum number of controllers per sector is 9.

4.13 It is recommended that, in future studies, at least 30 observations of each parameter be recorded for each controller at peak hours, respecting the minimum number of controllers specified by the sampling technique used. Based on resource availability, it is suggested that as many observations be made of as many controllers in the unit as possible. This recommendation helps avoid ruling out possible *outliers* (extreme values) and to minimise any type of existing trend, such as controllers and/or pilots extending or restricting communications so much that it could lead to an increase/reduction of the *tm* trend.

ATTACHMENT 3 TO APPENDIX C

ATC COMMUNICATIONS LOAD

UNIT:______ SECTOR(S):___________ | CA | SA | DATE: ____/____/____ COLLECTING AGENT:_________

REGISTRATION	IN	OUT	1	2	3	4	5	6	7	8	9	10	11	12	13

ATTACHMENT 4 TO APPENDIX C

AVAILABILITY FACTOR "F"

UNIT:___________ DATE: ____/____/____ COLLECTING AGENT:___________

SECTOR	CA	SA	START HHMM	END HHMM	t.s.a. (sec)	OBS

SECTOR	CA	SA	START HHMM	END HHMM	t.s.a. (sec)	OBS

t.s.a. – time spent in secondary activities

ATTACHMENT 5 TO APPENDIX C

Modelo de la FAA de Cálculo para sector ATC

Definition

<u>Sector capacity:</u> The optimum number of flights in a given sector, for a specified period of time that can be managed safely and efficiently.

Factors that affect sector capacity

The following factors can all have an impact on sector capacity:

a) Airway structure in the sector.
b) Airspace volume of the sector.
  1) Vertically
  2) Horizontally
c) Complexity of operations in the sector.
1) Number of adjoining sectors
2) Amount of climbing/descending traffic
3) Terrain
4) Military operations
5) Special use airspace

Steps for determining sector capacity

For each 15-minute time period:

a) Determine the average time a flight spends in a sector.
b) In most cases, this will be measured from 7am to 7pm, Monday through Friday.
c) Example:

20 flights are observed in the sector in 15 minutes
Add the flights individual sector times together
120 minutes

Divide 120 minutes by the 20 flights to obtain the average
120 minutes = 6 minutes / flight
20 flights
The quotient is the average sector flight time, in minutes
6 minutes

Next, multiply the average sector flight time by 60 seconds.

a) Example:
(6 minutes / flight) X (60 seconds) = 360 seconds / flight
The product is the average sector flight time, in seconds

Next, divide the average sector flight time, in seconds, by 36 seconds.

Note: 36 seconds is a value established for use in the United States by human factor experts. It represents the average time a controller interacts with a flight while it is in the sector.

b) Example:

The average sector flight time from above is 360 seconds per flight

Divide 360 seconds per flight by 36 seconds (the time a controller interacts with a flight)

360 seconds per flight = 10 flights
36 seconds

The quotient, 10, is the optimum sector capacity value for the 15 minute period.

Next, adjust the optimum sector capacity value for operational factors.

a) The value may be adjusted up or down, as appropriate, after taking into account the factors that affect the sector.

b) The factors include, but are not limited to:

1) Airway structure in the sector
2) Airspace volume of the sector -- vertically and horizontally
3) Complexity of operations in the sector
4) Number of adjoining sectors
5) Amount of climbing and descending traffic
6) Terrain
7) Military operations and special use airspace

c) Apply local, professional judgment and adjust the optimum sector capacity value up, or down, as necessary.

The optimum sector capacity adjusted for operational considerations is the sector capacity value.

OPTIMUM SECTOR CAPACITY VALUE
plus/minus +/- ADJUSTMENT FACTORS
equals SECTOR CAPACITY VALUE

A table method has also been developed for computing the Optimum Sector Capacity Value.

ATTACHMENT 6 TO APPENDIX C

Steps to Estimate Runway Capacity in Brazil

CALCULATING RUNWAY PHYSICAL CAPACITY

The following sequence of events shall be followed to estimate runway physical capacity:

Step 1

Data collection:

a) Runway occupancy time (ROT):

Recording in specific forms, constant values in Tables 1 and 2, respectively, Runway Occupancy Time during Take-Off (ROTT) data collection form, and Runway Occupancy Time during Landing (ROTL) data collection form, the runway occupancy times during take-off and landing operations distributed in their respective categories:

TABLE 1				
COLLECTION OF RUNWAY OCCUPANCY TIMES DURING TAKE-OFF (ROTT)				
SITE: __________ DATE: ____________ RUNWAY: _________				
REGISTRY	**TYPE**	**CAT**	**TIME**	**REMARKS**

TABLE 2				
COLLECTION OF RUNWAY OCCUPANCY TIMES DURING LANDING (ROT)				
SITE: __________ DATE: ____________ RUNWAY: _________				
REGISTRY	**TYPE**	**CAT**	**TIME**	**REMARKS**

Note 1: These data shall be collected next to the control tower or ATS unit of the aerodrome under study.

Note 2: The "remarks" column shall contain any data relevant to the validation of the collected data. For example: through which TWY has the aircraft cleared the runway after landing; or how long has the aircraft remained aligned after being cleared for take-off.

Step 2

b) Estimating the runway occupancy time arithmetical mean:

Each of the thresholds of the aerodrome shall be taken into account by inserting the referred data in Table 3 (Form to Calculate the Mean Runway Occupancy Times (ARR/DEP) by Aircraft Category).

After collecting runway occupancy times, the arithmetical mean, *inter alia*, is estimated by aircraft category:

TABLE 3

ARITHMETICAL MEAN OF RUNWAY OCCUPANCY TIMES DURING LANDING (MROTL), BY AIRCRAFT CATEGORY

AERODROME: ________________ RUNWAY: ______________

$\sum$ ROTL$_{CAT\ X}$ / Nº ACFT$_{CAT\ X}$

CAT	TIME (sec)
A	
B	
C	
D	
E	

ARITHMETICAL MEAN OF RUNWAY OCCUPANCY TIMES DURING TAKE-OFF (MROTT), BY AIRCRAFT CATEGORY

$\sum$ ROTT$_{CAT\ X}$ / #ACFT$_{CAT\ X}$

CAT	TIME (sec)
A	
B	
C	
D	
E	

ARITHMETICAL MEAN OF RUNWAY OCCUPANCY TIMES (AMROT), BY AIRCRAFT CATEGORY

AERODROME: ________________ RUNWAY: _______________

($\sum$MROTL+$\sum$MROTT)/2

CAT	TIME (sec)
A	AMROTA
B	AMROTB
C	AMROTC
D	AMROTD
E	AMROTE

AMROTA = $\frac{MROTTA+MROTLA}{2}$	**AMROTB = $\frac{MROTTB+MROTLB}{2}$**
AMROTC = $\frac{MROTTC+MROTLC}{2}$	**AMROTD= $\frac{MROTTD+MROTLD}{2}$**
AMROTE = $\frac{MROTTE+MROTLE}{2}$	

Step 3

c) Estimating aircraft mix

Based on total daily movement records obtained from any recognised statistical source that truly reflects the total movement of aircraft at the aerodrome, a weekly sample is obtained for estimating aircraft mix, and the resulting values are inserted in Table 4 (Form for Collecting Airport Percentage Utilisation Data by Aircraft Category - Mix).

TABLE 4

AERODROME PERCENTAGE UTILISATION BY AIRCRAFT CATEGORY (MIX)

AERODROME: _________________

MONDAY	
CAT	**# Aircraft (%)**
A	
B	
C	
D	
E	

TUESDAY	
CAT	**# Aircraft (%)**
A	
B	
C	
D	
E	

WEDNESDAY	
CAT	**# Aircraft (%)**
A	
B	
C	
D	
E	

THURSDAY	
CAT	**# Aircraft (%)**
A	
B	
C	
D	
E	

FRIDAY	
CAT	**#Aircraft (%)**
A	
B	
C	
D	
E	

TABLE 4 (CONT.)		
	MIX	
	CAT	**# Aircraft (%)**
	A	
	B	
$\sum$#Aircraft$_{CAT\ X}$ / # DAYS	**C**	
	D	
	E	

The value of the mix shall be determined by comparing the percentages, by day of the week, of the total number of aircraft in the respective day and the total number of aircraft in each category.

The following table illustrates aircraft mix calculation:

	MONDAY		**TUESDAY**		**WEDNESDAY**		**THURSDAY**		**FRIDAY**	
CAT	**Air-craft**	**%**	**Air-craft**	**%**	**Air-craft**	**%**	**Air-craft**	**%**	**Air-craft**	**%**
A	32	8.42%	29	7.63%	25	6.51%	39	9.68%	25	6.31%
B	55	14.47%	57	15.00%	61	15.89%	73	18.11%	66	16.67%
C	283	74.47%	283	74.47%	286	74.48%	282	69.98%	297	75.00%
D	6	1.58%	11	2.89%	11	2.86%	8	1.99%	8	2.02%
E	4	1.05%	0	0.00%	1	0.26%	1	0.25%	0	0.00%
Total	**380**	**100%**	**380**	**100%**	**384**	**100%**	**403**	**100%**	**396**	**100%**

ARITHMETICAL MEAN	
CAT	**MIX**
A	7.71 %
B	16.03 %
C	73.68 %
D	2.27 %
E	0.31 %
TOTAL	**100 %**

Step 4

d) Calculating Mean Runway Occupancy Time (**MROT**)

The values corresponding to runway occupancy times, by aircraft category, the constant values in Table 3, and the respective constant mix in Table 4 shall be taken to Table 5 (Calculating Mean Runway Occupancy Time), where the mean runway occupancy time (MROT) will be estimated using the weighted arithmetical mean.

TABLE 5

CALCULATING MEAN RUNWAY OCCUPANCY TIME (MROT)

AERODROME: __________________ RUNWAY: ___________________

AMROT			MIX			MROT
CAT	TIME (sec)		CAT	#AIRCRAFT (%)		TIME (sec)
A		X	A		=	
B			B			
C			C			
D			D			
E			E			

MROT= $\sum (\mathrm{AMROT}_{CATX} \cdot \mathrm{MIX}_{CATX}) / 100$

Step 5

e) The physical capacity PER runway (PCR) shall be calculated for a one-hour period, taking into account each threshold, by dividing the cited interval, translated to seconds (3600 sec), by the mean runway occupancy time, expressed in seconds.

PCR = 3600 / MROT

Step 6

f) Aerodrome physical capacity calculation

It shall be based on the mean annual utilisation of each runway, in terms of percentage, together with data on total monthly movements obtained from any recognised statistical source, which truly reflect the total movement of aircraft at the aerodrome from which the desired sampling will be obtained.

g) Runway utilisation percentage (UP):

An index calculated from the total monthly movement, obtained from a sampling containing data for a one-year period. Percentages are weighted against the capacity of each runway, the end result being a single value. The following tables illustrate how to calculate runway utilisation percentages:

MONTHLY MOVEMENT OF AIRCRAFT

MONTH	RWY A	RWY B	Monthly movement
JAN	7622	2631	10253
FEB	6364	3229	9593
MAR	9239	2409	11648
APR	9965	1184	11149
MAY	10811	896	11707
JUN	11280	291	11571
JUL	11637	620	12257
AUG	12145	263	12408
SEP	11687	273	11960
OCT	9177	2184	11361
NOV	7765	2936	10701
DEC	7487	3665	11152
TOTAL	**115179**	**20581**	**135760**

RWY	% UTILISATION (UP)
A	**86**
B	**14**
TOTAL	**100**

The mean annual percentage values per runway and the respective physical capacity values are weighted in order to obtain the physical capacity of the aerodrome, as defined in Table 6.

TABLE 6

AERODROME PHYSICAL CAPACITY (APC) CALCULATION

PCR		% OF RWY UTILISATION		
RWY A	X	% RWY A	=	AERODROME PHYSICAL CAPACITY
RWY B		% RWY B		

APC= $\sum (PCR_{RWYX} \cdot \%UTIL_{RWYX}) / 100$

THEORETICAL RUNWAY CAPACITY CALCULATION

Theoretical runway capacity is calculated for a sixty-minute interval, based on the mean runway occupancy time, taking into account ***regulatory aircraft separation, as well as the planning factors and landing and take-off operational factors*** of the aerodrome under study:

Runway occupancy times, aircraft mix, mean runway occupancy time, and annual runway utilisation percentage, will be used to calculate aerodrome and runway physical capacity, constant values in Tables 1 to 6.

Step 7

a) Flight time between the OM and the THR **(T)**

Flight times between the OM and the THR of the runway under study shall be collected and inserted in Table 7A (flight time between the OM and the THR), taking into account the various aircraft categories operating in the aerodrome. After calculating the respective mean values, they must be inserted in Table 7B (mean flight time between the OM and the THR), so as to calculate the mean speeds in the final approach for all thresholds.

TABLE 7A

FLIGHT TIME BETWEEN THE OM AND THE THR __________(T)

OM/THR DISTANCE ____________

REGISTRY	TYPE	CAT	TIME (SEC)	TIME (MIN)

TABLE 7B

MEAN FLIGHT TIME BETWEEN THE OM AND THE THR __________(MT)

OM/THR DISTANCE ____________

CAT	TIME (SEC)	TIME (MIN)
A		
B		
C		
D		
E		

MT = $\sum T_{CAT\ X} / \#\ AIRCRAFT_{CAT\ X}$

Note 1: Time is measured from the moment the aircraft crosses the outer marker until it crosses the runway threshold, or, in the absence of an outer marker, from the start of the final approach segment until crossing the runway threshold.

Note 2: Consider the distance between the OM and the THR, in NM.

Note 3: If there is no OM, we must select a point of a known distance in the final approach that determines the impossibility for any other aircraft to enter the runway while the landing aircraft is crossing it or is in any other segment between the referred point and the threshold under study.

Step 8

b) Estimating the landing approach speed between the OM and the THR **(V)**

With the data obtained from Tables 7A and 7B, we can estimate, for each runway, the landing approach speeds between the OM and the threshold and the final approach segment (FAS)--taking into account each aircraft category--and record the values found in Table 8 (mean speed between the OM and the THR).

Note 1: This speed is obtained by dividing the length of the final approach segment by the mean flight time, by aircraft category, between the outer marker and the runway threshold **(MT)**.

$$AVA = \frac{FAS}{MTA} \quad AVB = \frac{FAS}{MTB} \quad AVC = \frac{FAS}{MTC} \quad AVD = \frac{FAS}{MTD} \quad AVE = \frac{FAS}{MTE}$$

TABLE 8

MEAN SPEED BETWEEN THE OM AND THE THR ___________

CAT	SPEED (KT)	SPEED (NM/MIN)	SPEED (NM/SEC)
A			
B			
C			
D			
E			

SPEED (KT) = DIST (NM) / T FLIGHT $_{OM/THR}$ (H)

SPEED (NM/MIN) = DIST (NM) / T FLIGHT $_{OM/THR}$ (MIN)

SPEED (NM/SEC) = DIST (NM) / T FLIGHT $_{OM/THR}$ (SEC)

Step 9

c) Mean speed in the final approach (MV):

The weighted mean of final approach speeds, taking into account the aircraft mix.

$$MV = \frac{MIX_A\, xAVA + MIX_B\, xAVB + MIX_C\, xAVC + MIX_D\, xAVD + MIX_E\, xAVE}{100}$$

Step 10

d) Determination of safety separation (SS):

The study foresees the possibility of having a take-off between two consecutive landings, but without affecting the regulatory separation minima **(RSM)** between incoming and outgoing aircraft that, in Brazil, are established in ICA 100-12. This requires the calculation of a safety distance to be added to the regulatory separation minima between aircraft in the approach phase in order to allow an aircraft to take off after the first has landed, without compromising its regulatory separation with the second aircraft in the approach phase.

By estimating the distance flown by the second aircraft in the final approach while the first aircraft is on the runway, and by adding the calculated distance to the adopted regulatory separation minima, we obtain the separation required between two consecutive landings.

This flown distance is obtained by multiplying the mean speed in the final approach by the mean weighted runway occupancy time.

SS = MV x MROT

Step 11

e) Determination of total separation between two consecutive landings (**TS**):

The total separation is obtained by adding the safety separation and the regulatory separation minimum. Thus:

TS = SS + RSM

There are cases in which SS can be left out. Normally, this can happen at airports that have two or more runways, where operation dynamics can be enhanced by leaving an aircraft aligned on the runway while waiting for another aircraft to land on the other runway.

Step 12

f) Calculation of the mean weighted time between two consecutive landings, taking into account total separation (**MTTS)**.

The mean weighted time it takes to cover the total separation between two consecutive landings is obtained by dividing this distance by the mean weighted speed of the aircraft mix.

MTTS=TS/MV

Note 1: The mean time must be calculated for each threshold in the aerodrome, based on the different taxiway configurations for each threshold in use.

Step 13

g) Determination of the number of landings in a one-hour interval (P):

The resulting mean weighted time it takes to cover the total separation between two consecutive landings, in seconds, shall be the denominator for the number of seconds contained in an hour (3600 sec). The result will be the number of possible landings with the separation proposed for the threshold under study, according to Table 9.

TABLE 9
NUMBER OF POSSIBLE LANDINGS
3600 / MTTS = NUMBER OF LANDINGS

P = 1 hour / MTTS

Step 14

h) Determination of the number of take-offs in a one-hour interval (**D**):

Based on the total separation obtained, it is possible to insert a take-off between two consecutive landings. By subtracting one aircraft from the total number of landings, we obtain the possible number of take-offs within the time interval under study, according to Table10.

TABLE 10
NUMBER OF POSSIBLE TAKE-OFFS
NUMBER OF LANDINGS - 1 = NUMBER OF TAKE-OFFS

D = P-1

Step 15

i) Determination of theoretical runway capacity:

Add the resulting number of landings and take-offs in the sixty-minute interval for each threshold to obtain the theoretical operational capacity for the respective threshold, according to Table 11.

TABLE 11
THEORETICAL RUNWAY CAPACITY (TRC)
THEORETICAL RUNWAY CAPACITY = NUMBER OF LANDINGS + NUMBER OF TAKE-OFFS

TRC=Landings+Take-offs

CALCULATION OF THE DECLARED RUNWAY CAPACITY

The declared capacity is estimated taking into account the percentage annual utilisation of each runway, the same as the constant value in Table 6.

Step 16

a) Determining the declared capacity of the runway set (**DCR**)

The declared capacity of the runway set is the capacity that is fully sustainable from the operational point of view, taking into account the percentage annual utilisation of each runway. Accordingly, the weighted arithmetical mean between the utilisation percentage and the respective theoretical runway capacities is estimated.

Thus:

$$DCR = \frac{UPA \times TRCA + UPB \times TRCB + \ldots\ldots\ldots UPN \times TRCN}{UPA + UPB \ldots\ldots\ldots UPN}$$

Note: It should be noted that, as stipulated in DOC 9426, an ATC unit can not operate at full capacity throughout the whole operating shift, since there are several variables that significantly reduce capacity at certain times. Therefore, it is advisable to adopt percentages between 80% and 90%, thus giving more flexibility to capacity values, that is, an ideal interval that preserves the safety of air operations.

CONCLUSION

In order to maintain air traffic flow close to optimum conditions, avoiding possible system overloads, the CGNA has conducted studies to standardise the methods for estimating runway capacity, in the hope of analysing demand/capacity evolution at each airport, and to make recommendations to the airports involved for the sake of operational harmony.

The method presented herein is intended to show the use of the runway capacity calculation model in a general and simplified manner, and does not contemplate the many peculiarities of the aerodromes where it will be applied. Therefore, when conducting studies to determine aerodrome runway capacity, all factors that might affect the indices should be taken into account.

ACRONYMS

Meaning of the acronyms used in this Appendix.

ROT – Runway occupancy time/Tiempo de ocupación de pista

ROTT - Runway occupancy time during take-off/Tiempo de ocupación de pista durante el despegue

ROTL - Runway occupancy time during landing/Tiempo de ocupación de pista durante el aterrizaje

MROTL- Arithmetical mean runway occupancy time during landing per aircraft/Media aritmética de los tiempos de ocupación de pista durante el aterrizaje por categoría de aeronaves

MROTT- Mean runway occupancy time during take-off per aircraft category/Media aritmética de los tiempos de ocupación de pista durante el despegue por categoría de aeronaves

AMROT - Arithmetical mean runway occupancy time per aircraft category/Media aritmética de los tiempos de ocupación de pista por categoría de aeronaves

FAS – Final approach segment/Segmento de aproximación final

MTTS – Mean weighted time between two consecutive landings, taking into account total separation/Tiempo medio ponderado entre dos aterrizajes consecutivos, considerando la separación total

DCR – Declared capacity of the runway set/Capacidad declarada del conjunto de pistas

MROT – Mean runway occupancy time/Tiempo medio ponderado de ocupación de pista

ATTACHMENT 7 TO APPENDIX C

CALCULATION OF THE AERODROME ACCEPTANCE RATE (AAR) USED BY THE FAA

a. **Aerodrome Acceptance Rate (AAR):** The number of incoming aircraft that an aerodrome can accept per hour--also taking into account weather, terminal airspace, apron space, parking space and facilities.

b. **Main configuration of aerodrome runways**: The configuration of each aerodrome that handles 3 percent or more of annual operations.

c. **Potential AAR**: The theoretical acceptance rate in the runway threshold--before considering other factors.

d. **Actual AAR**: The potential AAR in the runway threshold, adjusted to other factors.
For any runway configuration, the Potential AAR minus the Adjustment Factors is equal to the actual AAR:

POTENTIAL AAR
-- ADJUSTMENT FACTORS

ACTUAL AAR

e. **Adjustment factors**: Factors that must be taken into account when establishing the actual AAR. These factors include, but are not limited to:
   1. weather
   2. runway conditions
   3. general availability of taxiways
   4. apron space
   5. facilities

Establishing the actual AAR

a. Establish the actual AAR values for the general runway configuration at each aerodrome, for the following weather conditions:

   1. Visual meteorological conditions (VMC) – meteorological conditions permit vectoring for visual approach.

   2. Marginal VMC – meteorological conditions do not permit vectoring for visual approach, but visual separation is possible in the final approach.

   3. Instrument meteorological conditions (IMC) – Visual approach and visual separation in the final approach are not possible.

Calculate the actual AAR as follows:

a. First, calculate the potential AAR.

1. Determine the average ground speed when crossing the runway threshold and the spacing required between successive arrivals.

2. Divide the ground speed by the spacing to determine the potential AAR.

3. METHOD USING A FORMULA: The ground speed at the runway threshold, expressed in knots, divided by the spacing at the runway threshold, expressed in miles.

NOTE: When the quotient is a fraction, round up to the next lower whole number.

4. Example 1: 130 KTS / 5 nm = 26
Potential AAR = 26 arrivals per hour

5. Example 2: 120 KTS / 7 nm = 17.14
round up to 17

Potential AAR = 17 arrivals per hour

6. Or use the TABLE METHOD for determining the potential AAR.

Table: Potential AAR

Nautical miles between aircraft at the runway threshold										
	3	**3.5**	**4**	**4.5**	**5**	**6**	**7**	**8**	**9**	**10**
	Potential AAR									
Ground speed at the runway threshold										
140 knots	46	40	35	31	28	23	20	17	15	14
130 knots	43	37	32	28	26	21	18	16	14	13
120 knots	40	34	30	26	24	20	17	15	13	12
110 knots	36	31	27	24	22	18	15	13	12	11

b. Then, identify any condition that might reduce the potential AAR. These conditions include:

1. Arrival and departure runways that cross

2. Lateral distance between arrival runways

3. Dual-use runways – runways that share arrivals and departures

4. Land and hold short operations

5. Availability of high-speed taxiways

6. Airspace limitations and restrictions

7. Procedural constraints (noise abatement, missed approach procedures)

8. Taxiway layout

9. Meteorological conditions

c. Finally, subtract the adjustments from the potential AAR to determine the actual AAR for each runway used in an aerodrome configuration.

POTENTIAL AAR
-- ADJUSTMENT FACTORS

ACTUAL AAR

d. Example

Table: EXAMPLE OF AN ACTUAL AAR TABLE

RUNWAY CONFIGURATION	AAR for VMC	AAR for MARGINAL VMC	AAR for IMC
RWY 13	24	21	19
RWY 31	23	20	17

Administrative considerations:

a. Identify the organisation responsible for the establishment and implementation of AARs in selected aerodromes.

b. Establish a table of actual AARs for the aerodromes identified in each State/Territory.

c. Review and validate the main runway configurations of the aerodrome and associated AARs at least once a year.

ATTACHMENT 8 TO APPENDIX C

DEMAND/CAPACITY ANALYSIS applied in Colombia - "ELDORADO" AIRPORT

1. INTRODUCTION

Every airport has a limited number of aircraft operations that the runway and taxiway system can accommodate. This limitation is known as aerodrome capacity. Aerodrome capacity is assessed in one-hour periods for the runway/taxiway system. The purpose of the Demand/Capacity analysis is to determine aerodrome capacity and to identify the improvements, if any, that may be necessary to face future demand.

There are a several methods or models (empirical, analytical, queues, and manuals) for calculating airport capacity.

Colombia has developed the demand/capacity analysis on the basis of the FAA standard method.

2. DEMAND/CAPACITY ANALYSIS– "ELDORADO" AIRPORT

The FAA standard method used to determine airport capacity and delay for purposes of long-term planning is described in "Advisory Circular (AC) 150/5060-5, Change 2, "Airport Capacity and Delay". This model has been derived from computer models used by the FAA to analyse airport capacity.

Since the airport and the hourly capacity of its components vary according to the constant changes in the operational configuration of runways, the fleet mix operating in it, ATC regulations, etc., it was necessary to develop some of the calculations described in the cited methodology so as to calculate hourly runway capacity.

When performing the analysis to determine airport runway capacity, several factors are taken into account, as described below:

2.1. AERODROME CHARACTERISTICS

In order to properly conduct the FAA capacity analysis, it was necessary to identify some operational conditions and aerodrome characteristics. The elements affecting aerodrome capacity are:

- Runway configuration;
- Aircraft mix index;
- Taxiway configuration;
- Operational characteristics; and,
- Weather conditions

The joint analysis of all the aforementioned elements served as a basis for establishing airport operational capacity. Next, each capacity characteristic of the "Eldorado" airport was assessed.

2.1.1. RUNWAY CONFIGURATION

Runway configuration includes two 3800m-long parallel runways, with 1400m spacing, a 1300m staggering, and a NW/SW orientation.

This analysis assumes that the “runway” includes the landing surface as well as the different segments of the approach path shared by all aircraft.

2.1.2. AIRCRAFT MIX INDEX

Knowing the fleet mix operating at the airport according to the statistics of the UAEAC P.I.S.T.A. system, it was possible to establish the mix index required to apply the FAA method for calculating aerodrome capacity. The estimation of the mix index is based on the relative percentage of the operations carried out by each of the four classes of aircraft (A, B, C, D), according to its MTOW.

The table below shows the physical aspects of the four classes of aircraft and their relationship with wake turbulence classification standards.

<table>
<tr><th>AIRCRAFT CLASS</th><th>MAXIMUM CERTIFIED TAKE-OFF WEIGHT</th><th>NUMBER OF ENGINES</th><th>CLASSIFICATION BY WAKE TURBULENCE</th></tr>
<tr><td>A</td><td rowspan="2">12.500 lbs or less
7000 kg or less</td><td>One engine</td><td rowspan="2">S (Small)
L (Light)</td></tr>
<tr><td>B</td><td>Multi- engine</td></tr>
<tr><td>C</td><td>12.500 – 300.000 lbs
7000 kg – 136000 kg</td><td>Multi- engine</td><td>L (Large)
M (Medium)</td></tr>
<tr><td>D</td><td>Over 300.000lbs
Over 136000 kg</td><td>Multi- engine</td><td>H (Heavy)
H (Heavy)</td></tr>
</table>

The formula of the FAA method to calculate the mix index is:

$$\%(C + 3D)$$

Where:

C - percentage of category C aircraft,

D - percentage of category D aircraft.

Note: *Aircraft categories A and B are not considered when calculating the mix index.*

Aircraft mix was determined based on the data requested in the following tables:

AIRCRAFT		MIX IN VFR		MIX IN IFR	
DESCRIPTION	**CLASS**	**No. ops**	**% ops**	**No. Ops**	**% ops**
ONE ENGINE	**A**	**3**	**9**	**3**	**9**
LIGHT TWIN-ENGINE	**B**	**3**	**9**	**3**	**9**
TRANSPORT-TYPE	**C**	**24**	**76**	**24**	**76**
WIDE BODY	**D**	**2**	**6**	**2**	**6**
TOTAL (No. Ops and % ops)		**32**	**100**	**32**	**100**

Rwy 13L

AIRCRAFT		MIX IN VFR		MIX IN IFR	
DESCRIPTION	**CLASS**	**No. ops**	**% ops**	**No. Ops**	**% ops**
ONE ENGINE	**A**	**1**	**3**	**1**	**3**
LIGHT TWIN-ENGINE	**B**	**2**	**7**	**2**	**7**
TRANSPORT-TYPE	**C**	**24**	**80**	**24**	**80**
WIDE BODY	**D**	**3**	**10**	**3**	**10**
TOTAL (No. Ops and % ops)		**30**	**100**	**30**	**100**

Rwy 13R

The mix index identified for “ElDorado” airport is:

Runway 13L

% (76+3(6)) = **94**

Runway 13R

% (80+3(10)) = **110**

Note: *It may be noted that with an increasing mix index, aerodrome capacity will gradually drop. This is mainly because the ATC must provide greater separation between C and D aircraft and those of other categories, due to the wake turbulence generated by bigger aircraft.*

2.1.3. TAXIWAY CONFIGURATION

Based on the FAA criterion for properly located exit taxiways, the exit factor is maximised when a runway has four exit taxiways within a range determined by the aircraft using the runway. For a mix index between 81 and 120, and depending on aerodrome elevation, this range is between 2377 m and 3328 m from the landing threshold.

Based on the FAA criterion, runway 13L has one exit taxiway, and runway 13R has two exist taxiways within the range for arrivals.

2.1.4. OPERATIONAL CHARACTERISTICS

The operational characteristics that may significantly affect aerodrome capacity include the arrival percentage and the percentage of touch and go´s (T&G) or runway training.

2.1.4.1. Percentage of arrivals

The percentage of arrivals is the relationship between landing operations and total airport operations.

This percentage is taken into account because an aircraft approaching an airport to land needs more runway occupancy time than an aircraft taking off. The FAA methodology applied here provides an arrival figure with percentages of 40, 50, or 60 in order to calculate aerodrome capacity.

$$\textbf{\% of arrivals} = \frac{(A + \frac{1}{2}(T\&G))}{A + DA + (T\&G)} \times 100$$

Where:

A = No. of aircraft arriving within the hour.
DA = No. of aircraft taking off within the hour.
T&G = No. of T&G within the hour.

Based on statistical data, it was determined that the percentage of arrivals for “Eldorado” airport is the following:

Runway 13L

$$\textbf{\% of arrivals} = \frac{(15 + \frac{1}{2}(0))}{15 + 17 + (0)} \times 100$$

$$\textbf{\% of arrivals} = 47$$

Runway 13R

$$\text{\% of arrivals} = \frac{(14 + \tfrac{1}{2}(0))}{14 + 16 + (0)} \times 100$$

$$\text{\% of arrivals} = 47$$

2.1.4.2. Percentage of Touch and Go´s (T&G)

The percentage of touch and go´s plays a key role in determining airport capacity.

Touch and go’s are counted as one landing and one take-off (two operations) and are normally associated with runway training.

*No runway training is carried out at the “Eldorado” airport.

2.1.5. DEMAND – “ELDORADO” AIRPORT

In order to apply the FAA method, operational demand at the “Eldorado” airport and its behaviour over the last 2 years were analysed, in order to obtain the information required by the method.

The growth of demand and its characteristics were also analysed in order to identify future capacity issues and the processes to be implemented in order to keep capacity and demand in balance.

Operational demand has increased 10% in the last two years; the demand value used for this analysis was 62 operations.

2.1.6. WEATHER CONDITIONS

Weather conditions affect the operational configuration of the aerodrome, taking into account wind and other related weather conditions. Hence, these conditions can affect aerodrome capacity. Runway utilisation is normally driven by wind conditions, while visibility determines the spacing required between aircraft in the approach sequence.

Based on statistical data, runways 13R and 13L account for approximately 89% of total annual operations (take-offs and landings). This is because SE/NW winds prevail most of the year. It should be noted that runway 13R has ILS CAT II approach minima.

There are three cloud ceiling and visibility levels recognised by the FAA for calculating airport capacity. Such ceilings are:

- (VFR) – cloud ceiling over 1,000 ft AGL and visibility is 3 sm (4837m) or greater.

- (IFR) – cloud ceiling is 500 ft AGL or more but less than 1,000 ft AGL and/or visibility is 1 sm (1609m) or more but less than 3 sm (4837m).

- (PVC) – Reduced visibility and cloud ceiling – cloud ceiling is less than 500 ft AGL and/or visibility is less than 1 sm (1609m).

3. AERODROME CAPACITY ANALYSIS

The aforementioned aerodrome characteristics were used along with the methodology developed by the FAA in order to determine aerodrome capacity. As already mentioned, this FAA methodology yields the runway hourly capacity.

4. RUNWAY HOURLY CAPACITY

The runway hourly capacity is the maximum number of aircraft that can be accommodated by a given runway configuration at an airport within a one-hour period. Using the FAA methodology, the runway hourly capacity is calculated using the appropriate VFR and IFR figures for a given airport runway configuration. In these figures, the aircraft mix index and the percentage of arrivals are used to calculate the base hourly capacity. Additionally, a T&G factor is determined based on the percentage of T&G operations combined with the aircraft mix index.

*The T&G factor for "Eldorado" airport is 1, since no runway training is performed at this airport.

These figures also take into account the exit factor.

Both for VFR and IFR conditions, the runway hourly capacity is calculated by multiplying the base hourly capacity, the T&G factor, and the exit factor. The equation is the following:

Hourly Capacity = C* x T x E

Where:

C* = base hourly capacity,
T = T&G factor,
E = exit factor.

An airport mix index can substantially change the value of the base hourly capacity in the FAA capacity tables.

The capacity figures taken from the FAA manual for the "Eldorado" airport are the following:

VFR Fig. 3-3
IFR Fig. 3-43

5. RESULTS OF THE DEMAND/CAPACITY ANALYSIS

MET	RWY. CONF.		CAP. FIG.	ACFT. MIX				%(C+3D)	% ARR	% T&G	RWY EXT (00 m)			BASE HOUR CAP. (C*)	T&G FACTOR (T)	EXIT FACTOR (E)	HOURLY CAP. (C*T*E)
	DIAG.	No		% A	% B	% C	% D				LOC.		No				
13L VFR	____	1	3-3	9	9	76	6	94	47	0	26		1	56	1	0,89	50
13L IFR	____	1	3-43	9	9	76	6	94	47	0	26		1	51	1	0,89	45
13R VFR	____	1	3-3	3	7	80	10	110	47	0	25	31	2	57	1	0,93	53
13R IFR	____	1	3-43	3	7	80	10	110	47	0	25	31	2	51	1	0,94	48

6. CONCLUSION

HOURLY CAPACITY "ELDORADO" AIRPORT OPS/HR		
RUNWAY	**VFR**	**IFR**
13L	**50**	**45**
13R	**53**	**48**

Once the runway hourly capacity has been determined, a performance factor between 0.6 and 0.9 must be applied so as to take into account factors affecting capacity and that are difficult to measure and control.

7. OBSERVATIONS

After analysing the demand, and having determined the hourly capacity, and followed up on the operation after ATFM implementation at "Eldorado" airport, it has been noted that:

- During certain periods at the "Eldorado" airport, there are subsequent demands that exceed capacity and cause unacceptable delays.

- During certain periods at the "Eldorado" Airport, when the hourly demand is lower than hourly capacity, delays occur at intervals within the hour in which demand exceeds capacity.

- Demand size and scheduling by the operators is relatively unrestricted in relation to capacity per hour and per hourly intervals.

ATTACHMENT 9 TO APPENDIX C

Guidelines for Improving Capacity

In order to improve the capacity of the system as a whole, it is advisable to analyse and identify the factors that may result in a reduction of airport and ATC sector capacity. Each factor has a weight in the capacity value, which varies according to the specific characteristics of the airport under study.

Some of the factors--not all factors are present in all systems--that may contribute to a reduction in capacity are as follows:

Longitudinal and Lateral Aircraft Separation Minima

Separation is established for safety reasons, both to avoid collisions and to prevent an aircraft from entering the wake turbulence of another aircraft, which is usually more critical when close to landing or during take-off, due to the low speeds applied. Runway configuration--the relative position and distance between runways--determines the interference that movements in one runway have on the other airport runways.

Procedures and Practices in Use

a) Most airports are designed to serve the most common operation based on prevailing winds.
b) Taxiways and parking aprons are built to serve the primary operation of the airport.
c) Approach and departure procedures are designed to serve the primary operation of the airport
d) Changes in the runway-in-use during traffic peaks may cause congestion.
e) Changes in runways may create disadvantages for certain instrument departure or arrival procedures.

Weather conditions

Under adverse weather conditions (low ceiling and visibility), pilots and controllers work “more cautiously” and separations are extended, resulting in reduced capacity.

Aircraft Mix

Aircraft category and performance determine the time between two consecutive operations. It has been shown that the interval between the landing of a heavy aircraft and the landing of a light aircraft is much greater if the heavy aircraft lands first. This fact suggests the possibility of having an optimum sequencing of the aircraft waiting to land at a given airport. The aircraft sequencing problem is typically formulated as an issue of restricted optimisation, with a view to finding sequences that maximise the runway service ratio without excessively penalising some types of aircraft.

Typical demand (take-off and landing mix)

Large concentrations of take-offs or landings can upset airport traffic flow.
Delays in take-off can cause taxiway occupancy and approach problems.
Landing sequencing may be affected by runway and taxiway configuration.

Type of operation (landing/take-off ratio)

The spacing between movements depends on the types of operations covered; that is, a landing performed following a take-off requires a different spacing compared to a take-off performed following another take-off. Capacity varies according to landing-to-take-off ratio. Consequently, a single capacity indication makes no sense, in contrast with a capacity indication based on the operation mix.

Quality and performance of navigation, surveillance, and control systems

Reliable and precise systems allow for a reduction in aircraft spacing, thus increasing capacity. The use of decision-support software to assist the controller, for instance, to foresee the optimum sequencing for aircraft approaching a given airport, provides for safe and rational operations.

Controller and pilot performance

More experienced controllers and pilots make for more agile operations. A good example is the Congonhas airport, where controllers use the two runways for landings and take-offs; pilots conduct take-offs without stopping at the runway threshold (immediate take-off); pilots in slower aircraft try to maintain speeds that are consistent with those of commercial aircraft; etc.

Location and types of runway exits

Landing runway exits, when properly located, allow pilots to leave the landing runway towards the taxiway system as soon as they have slowed down enough. If the exit is a fast exit, that is, at an angle of less than 90^o with the landing runway, there is no need to reduce speed too much, thus reducing runway occupancy time.

Environment

Noise can restrict operations on certain inhabited areas or fauna protection areas, generating additional restrictions to be considered when determining exit routes.

Restricted, prohibited, and dangerous areas

The existence of many restricted, prohibited and dangerous areas close to airports that do not apply procedures for coordination and flexible use of airspace constitutes an additional restriction to aircraft departure capacity.

Some of these factors may be of a temporary or permanent nature, depending on conditions. If they are considered permanent, they must be included in capacity calculations. Temporary factors, such as atmospheric conditions that can have a temporary impact on ATC sector capacity or airport operation, are managed by the ATC entity.

All these factors have an impact on the methodology used to determine capacity, and thus the importance of conducting a delay analysis.

This activity considers the available data coming from the recurrent delay monitoring process, but a more in-depth analysis of local circumstances is performed. The following is considered:

- Historical evaluation of delays
- Actual reason(s) for delays
- What is meant by ATC/Aerodrome delays?
- Who is involved in the capacity declaration process and is there a buy-in from all the stakeholders (the capacity declaration should reflect ATC/Aerodrome limits)?
- What are the reasons for additional traffic over and above the capacity declaration?
- How is extra traffic such as General Aviation accommodated?
- How many off-slot operations are experienced and how these are dealt with?
- Is there an (efficient) slot monitoring committee?

Airport delays should not be considered in isolation. Capacity at a number of airports is limited and action is required to ensure that capacity is not exceeded by demand at a particular moment on the day of operations.

Maximum airside capacity is not solely reliant on runway capacity. Aprons and taxiways must be capable of maintaining sufficient traffic throughput to match runway capacity. Terminal area capacity, arrivals and departures, the terminal building, ATC staff levels, and equipment should not be neglected during the capacity declaration process.

The demand-to-capacity ratio provides insight into the potential for delays at an airport. Together with the demand-to-capacity ratio used for defining traffic levels, medium-term annual demand data, based on airport-specific high, baseline and low forecasts for each of the selected airports are considered in this activity.

Some airports publish detailed demand and capacity analyses, taking into account hourly and seasonal variations, while others only publish an overall declared hourly capacity.

As general guidance, a plan to optimise capacity could include the following steps:

Step 1 – Establish a capacity baseline
Step 2 – Determine future demand

Step 3 – Determine if there will be a capacity reduction
Step 4 – Identify all limitations that affect capacity
Step 5 – Quantify the impact of limitations
Step 6 – Identify possible corrective actions and best practices
Step 7 – Identify the impact and cost of corrective actions
Step 8 – Establish priorities
Step 9 – Develop the capacity improvement plan

APPENDIX D

FLEXIBLE USE OF AIRSPACE

DINACIA Regulation Number

Version 0.4
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Prepared by:
Air Traffic Technical Chief

Reviewed by:
Air Traffic Bureau

DINACIA

Document Control

Date	Prepared by	Reviewed by	Approved by	Version
SEP-2009	Roberto Arca	Cnl. (AF) Hugo Jackson		0.4

National Regulations on the Flexible Use of Airspace

FLEXIBLE USE OF AIRSPACE

Regulation number xxxxxx establishing common standards for the flexible use of airspace

CONSIDERING the need to regulate the flexible use of airspace under national responsibility in order to ensure compliance with ICAO recommendations with a view to increasing airspace capacity and improving the efficiency and flexibility of aircraft operations.

WHEREAS:

(1) the flexible use of airspace is an airspace management concept described by the International Civil Aviation Organization (ICAO) that seeks optimisation, balance, and equity in the use of airspace by civil and military users, through strategic coordination and dynamic interaction, and based on the resolutions of the 35th meeting of the ICAO Assembly, the GPI-1 initiative of the Global Air Navigation Plan (ICAO Doc.9750), GREPECAS, and the National Air Navigation Plan.

(2) these regulations do not include military operations and drills, which will be addressed in due time in Letters of Operational Agreement between military authorities and air traffic services (ATS).

(3) national military requirements must be taken into account to ensure that all airspace users fully and consistently apply the concept of flexible use of airspace.

(4) the flexible use of airspace must include airspace in the high seas within the jurisdiction of the Montevideo FIR. Therefore, it must be applied without detriment to the rights and obligations of member States under the Convention on International Civil Aviation (Chicago Convention), of 7 December 1944, and its Annexes, or the United Nations Convention on the Law of the Sea, of 1982.

(5) there are activities that require that a certain volume of airspace be reserved for their exclusive or special use (SUA) during certain periods of time, due to their flight profile characteristics or the risks involved in the operations to be carried out in said volume, and the need to separate them effectively and safely from other types of aeronautical activities.

(6) the effective and harmonised application of the flexible use of airspace throughout the Montevideo FIR requires precise and dynamic standards for civil-military coordination that take into account the needs of all users and the nature of their various activities.

(7) the efficacy of civil-military coordination procedures must be based on standards and procedures that allow for an efficient use of airspace by all users.

(8) the flexible use of airspace concept includes airspace management functions--strategic, pre-tactical, and tactical management--that are independent but closely related, and that must be performed in a coordinated manner to ensure an efficient use of airspace.

(9) technical cooperation programmes within the regular ICAO programme for air traffic management that are being implemented in the ICAO SAM Region must gradually achieve

consistency among airspace management, air traffic flow management, and air traffic service functions.

(10) when various aeronautical activities with different needs are carried out in the same airspace, their coordination must seek safety of flight operations and optimum use of available airspace.

(11) timely distribution and accuracy of the information sent to civil and military controllers regarding airspace status and specific air traffic situations have a direct impact on the safety, efficacy, and efficiency of operations.

(12) timely access to updated information on airspace status is vital for all parties willing to use available airspace structures when preparing or modifying their flight plan.

(13) the periodic assessment of airspace utilisation is an important way of increasing the confidence of civil and military service providers and users, as well as an indispensable tool for improving airspace design and management.

(14) the need for an adjustment period to meet the needs of coordination between civil and military air traffic service units and military control units must be taken into account.

THE DINACIA ENACTS THE FOLLOWING REGULATIONS

REGULATIONS

Article 1

Purpose

1.1 These Regulations constitute a regulatory framework that strengthens and harmonises the application of the flexible use of airspace concept in Uruguayan airspace, and establishes standards to support cooperation between civil and military services responsible for air traffic management, which operate in the airspace under the jurisdiction of the Eastern Republic of Uruguay.

Article 2

Definitions

a) "airspace management cell" ("AMC"), a cell responsible for day-to-day airspace management.

b) "airspace reservation", a defined volume of airspace temporarily reserved for exclusive or specific use by certain user categories.

c) "airspace restriction", a defined volume of airspace within which activities dangerous to the flight of aircraft may exist at specified times ("danger area"); or an airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is restricted in accordance with certain specified conditions ("restricted area"); or an airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is prohibited ("prohibited area").

d) "airspace structure", a defined volume of airspace designed to guarantee aircraft operations under optimum conditions of efficiency and safety.

e) "air traffic services unit" ("ATS unit"), the unit, whether civil or military, responsible for the provision of air traffic services.

f) "civil-military coordination", coordination between the civil and military parties that have decision-making power, to carry out coordinated actions to ensure the efficiency and safety of air operations in the airspace under their responsibility.

g) "military control unit", any fixed or mobile military unit responsible for air traffic operations or other activities that, by nature, may require reservation or restriction of the airspace.

h) "intention of flight", the flight path and related data that describe the foreseen path of a flight to its destination, with the updates made at any time.

i) "flight path", the path of an aeroplane through the air, defined in three dimensions.

j) "real time ", the effective time during which a process or event takes place.

k) "separation", spacing between aircraft, levels, or tracks.

l) "users", the civil or military aircraft operating in the air, as well as any other parties that need to use the airspace.

Article 3

Governing Principles

3.1 The concept of flexible use of airspace will be based on the following principles:

a) coordination between civil and military authorities will be organised at the strategic, pre-tactical, and tactical level, through the establishment of Letters of Operational Agreement and/or special procedures for a defined activity, aimed at increasing safety and airspace capacity and enhancing efficacy and flexibility of air operations;

b) consistency among air traffic management, air traffic flow management, and air traffic service functions must be established and maintained in order to ensure an efficient planning, distribution to all users and use at the three levels of airspace management (strategic, pre-tactical, and tactical);

c) airspace reservation for exclusive or specific use by certain user categories will be temporary and only for limited periods of time, based on actual use, and will cease as soon as the activity that gave rise to it ceases, and will follow the procedures established in ICAO documents and Annexes, as well as those prescribed in the Letters of Operational Agreement and/or special procedures;

d) air traffic service units and users will use available airspace in the best possible way.

Article 4

Strategic Airspace Management (Level 1)

4.1 Civil and military units that provide air traffic services will perform the following functions:

a) ensure the application of the flexible use of airspace concept at the strategic, pre-tactical, and tactical level;

b) review user needs regularly;

c) validate the activities that require airspace reservation or restriction;

d) define temporary airspace structures and procedures that offer multiple reservation and route options;

e) establish criteria and procedures for the establishment and use of adjustable lateral and vertical limits for the airspace needed to accommodate flight path variations and short-term flight changes;

f) assess national airspace structures and the route network in order to plan flexible airspace structures and procedures;

g) determine the specific conditions under which the responsibility for separating civil from military flights will fall upon civil and military air traffic service units or upon military control units;

h) establish and offer users airspace structures in close cooperation and coordination with neighbouring member States when the corresponding airspace structures have a significant impact on cross-border traffic or on the boundaries of flight information regions, with a view to ensuring an optimum use of airspace by all users;

i) establish consultation mechanisms between individuals or bodies and all the parties and organisations involved, in order to properly meet user needs;

j) assess and review periodically the procedures and operations involved in the flexible use of airspace;

k) establish mechanisms to store data regarding requests, assignment, and actual use of airspace for their subsequent analysis and for the planning of activities.

4.2 Both civil and military authorities that share the responsibility for, or participate in, airspace management will perform the functions listed in item 1, through close civil-military coordination as defined in a Letter of Operational Agreement.

4.3 The Letter of Operational Agreement will establish the agreements and procedures foreseen for a flexible use of airspace, and will specify, *inter alia,* the following:

a) the horizontal and vertical limits of the airspace involved;

b) the classification of the airspace available for use by civil air traffic;

c) the units or authorities responsible for airspace transfer;

d) the conditions for airspace transfer to the ATC unit involved;

e) the conditions for airspace transfer from the ATC unit involved;

f) periods of airspace availability;

g) any limitations in the use of the airspace involved; and

h) any other relevant procedures or information.

Article 5

Pre-tactical Airspace Management (Level 2)

5.1 If necessary, military and civil units will establish an airspace management cell (AMC) for airspace assignment, in keeping with the concepts, conditions, and functions described in Article 4, item 1. This AMC will also comply with the Letter of Operational Agreement and/or the temporary special procedures agreed upon.

5.2 Civil and military units will guarantee the introduction of appropriate support systems that will allow the airspace management cell to manage airspace assignment operations and give timely notice of airspace availability to all users involved, airspace management cells, air traffic service providers, and all the corresponding parties and bodies.

Article 6

Tactical Airspace Management (Level 3)

6.1 Civil and military units will guarantee the establishment of civil-military coordination procedures, as well as communication channels between air traffic service units and military control units for the exchange of airspace data with a view to real-time activation, deactivation, and redistribution of the airspace assigned at the pre-tactical level.

6.2. The DINACIA, through the *Dirección de Circulación Aérea* (Air Traffic Bureau) and the respective military command, will ensure that the relevant military control units and air traffic service units inform each other, in a timely and efficient manner, of any change in the planned airspace activation, and notify all users involved of the effective airspace status.

6.3 The DINACIA, through the *Dirección de Circulación Aérea* (Air Traffic Bureau) and the respective military command, will promote the introduction of coordination procedures and support systems between air traffic service units and military units that carry out activities in the airspace, in order to ensure a safe management of the interaction between civil and military flights.

6.4 The DINACIA, through the *Dirección de Circulación Aérea* (Air Traffic Bureau) and the respective military command, will ensure the establishment of coordination procedures between civil and military air traffic service units to permit direct communication of relevant information to address concrete traffic situations in the same volume of airspace in which civil and military controllers provide services. The relevant information will be made available, especially when so required for safety reasons, to civil and military controllers and military control units through prompt exchange of flight data, including the position and intention of flight of the aircraft.

Article 7

Safety Assessment

7.1 In order to maintain and improve current safety levels, the DINACIA, through the *Dirección de Circulación Aérea* and the respective military command, will ensure that, within the safety management process and before introducing any change in the implementation of flexible use of airspace, a safety assessment will be conducted, including the determination of dangerous situations and risk analysis and mitigation.

7.2 In this sense, a risk analysis according to SMS procedures can be conducted.

Article 8

Reports

8.1 In its annual reports on the application of the flexible use of airspace, the DINACIA, through the *Dirección de Circulación Aérea* and the respective military command, will provide information for the assessment of the operation of the agreements, procedures, and support systems established at the strategic, pre-tactical, and tactical level of airspace management.

8.2 The assessment will cover safety, airspace capacity, efficacy, and flexibility of aircraft operations of all users, and may refer to:

a) issues encountered during the application of these Regulations, measures taken, and changes required,

b) the results of inspections, reviews, and national safety audits,

c) the cooperation provided by DINACIA, through the *Dirección de Circulación Aérea* and the respective military command, in terms of airspace management and, especially, regarding the establishment and management of cross-border airspace and cross-border operations,

d) SMS analysis.

Article 9

Assurance of compliance

9.1 The DINACIA, through the *Dirección de Circulación Aérea*, and the respective military command, will monitor compliance with these Regulations through periodic assessments, studies and safety audits.

Article 10

Entry into Effect

10.1 These Regulations will enter into effect on the day after their publication in the official newspaper of the ROU.

10.2 Article 6 will become effective 6 months after the effective date of these Regulations.

10.3 These Regulations will be mandatory in all of their elements, and directly applicable to civil and military units that use the airspace under the jurisdiction of the Eastern Republic of Uruguay.

Signed by DINACIA

APPENDIX E

ACTION PLAN FOR THE IMPLEMENTATION OF ATFM AT SAM AIRPORTS				
A: AIRPORT				
Task description	**Start**	**End**	**Responsible party (designate individual or organisation in charge)**	**Remarks**
1. Airport demand/capacity analysis	**Sep 2008**	**Apr 2010**		
1.1 Prepare ATFM survey	N/A	Aug 2008	Project RLA/06/901 RO	**Finalised**
1.2 Send survey to the States of the Region	Aug 2008	SAM/IG/2	RO	**Finalised**
1.3 Analyse the methodology presented by Brazil for estimating airport capacity	June 2008	SAM/IG/2	ATFM/IG	**Finalised** and analyzed through WP/8, WP/16.
1.4 Send response to survey	N/A	SAM/IG/2	E	**Finalised** Except for French Guyana, Guyana, and Suriname.
1.5 Assess survey results	N/A	SAM/IG/3	ATFM/IG	**Finalised**
1.6 Course offered by Brazil on Airport Capacity Estimate	Mar 2009	Mar 2009	Brazil	**Finalised** The course was carried out from 23 – 27 March 2009, as planned
1.7 Development of the Methodology for the Calculation of Airport and Airspace Capacity in the SAM Region	Nov 2008	Jan 2009	Brazil and USA RLA/06/901	**Finalised** Result to be presented at SAM/IG/4
1.8 Carry out exercise of Calculation of Airport and Airspace Capacity in the SAM Region as per the Course offered by Brazil	Sept 2009	SAM/IG/4	E	**Finalised**
1.9 Carry out Calculation of Airport and Airspace Capacity of main airports by States.	Sept 2009	SAM/IG/5	E	
1.10 Identify airports where periods exist where the demand is greater than existing capacity including simulations, if necessary, by States.	Sept/Oct 2009	SAM/IG/5	E	

ACTION PLAN FOR THE IMPLEMENTATION OF ATFM AT SAM AIRPORTS				
A: AIRPORT				
Task description	**Start**	**End**	**Responsible party (designate individual or organisation in charge)**	**Remarks**
1.11 Determine operational factors affecting airport demand and capacity to optimise utilisation of existing capacity, including simulations, is necessary.	Sept/Oct 2009	SAM/IG/5	E	
2. Coordination with the ATM community	**Sep 2008**	**Jun 2009**		
2.1 Present initial AIC model	SAM/IG/2	SAM/IG/2	ATFM/IG	**Finalised**
2.2 Publish initial AIC	SAM/IG/2	Next AIRAC date/2009 after SAM/IG/3	E	**Finalised**
2.3 Promote seminars to the ATFM community, taking into account the CDM concept for ATFM implementation, and begin the relevant coordination		Second half 2010	E	
2.4 Inform the GREPECAS ATM Subgroup			RO	
3. Infrastructure and database		**Aug 2008**		
3.1 Send the results of the survey developed by the hired expert to the Automation Group.		Dec 2008		**Finalised**
3.2 Send to the Automation Group the information obtained by the expert hired on the data bases used in the Brazil, United States and Eurocontrol units	Jan 2009	TBD		
3.3 Coordinate implementation activities with the Automation Group			ATFM/IG	Permanent
4. Policy, standards, and procedures			**Nov 2008**	
4.1 Hire expert to draft the manuals on ATFM measures for airports and FMU and FMP procedures			N/A	Task included in 4.2
4.2 Hiring of an expert for the elaboration of the ATFM Manual		February 2009	RO	**Finalised**. Task developed from 6 to 17 July 2009
4.3 Detailed development of ATFM Manual chapters	Dec 2008	SAM/IG/5	RO	Valid Approved partial draft, including ATFM concepts for airspace and airports at SAM/IG/2 Meeting

ACTION PLAN FOR THE IMPLEMENTATION OF ATFM AT SAM AIRPORTS				
A: AIRPORT				
Task description	**Start**	**End**	**Responsible party (designate individual or organisation in charge)**	**Remarks**
				To acknowledge status of implementation at SAM/IG/4. The initial task shall be developed from 6-17 Jul 2009.
4.4 Detailed development of the second part of ATFM Manual Chapters.	Dec 2009	Jun 2010	RO (RLA/06/901)	
4.5 Present the model AIC Supplement		SAM/IG/6	ATFM/IG	
4.6 Approve the AIC Supplement		SAM/IG/6	ATFM/IG	
4.7 Publish the AIP Supplements		AIRAC date prior to SAM/IG/7	E	
4.8 Develop CDM Manual		SAM/IG/5	RO (RLA/06/901)	
5. Training	**Sep 2008**			
5.1 Draft ATFM training plans and submit them		SAM/IG/5	E	RO shall request this requirement to States.
5.2 Train the team on decision-making at airports		Aug 2009	E	Permanent
5.3 Hire expert to draft Manual on the Introduction to ATFM for the ATM Community		TBD	RO	Guidelines to inform ATM community on ATFM and CDM general concepts. These guides may be provided in courses, seminars or others TBD.
5.4 Present and assess the Manual for the Introduction to ATFM for the ATM Community		First half of 2010	RLA/06/901	
5.5 CDM Course/Workshop for ATFM planners. 5.6				
5.6 Train the members of the ATM community in the CDM and ATFM concepts		TBD	E	

ACTION PLAN FOR THE IMPLEMENTATION OF ATFM AT SAM AIRPORTS				
A: AIRPORT				
Task description	**Start**	**End**	**Responsible party (designate individual or organisation in charge)**	**Remarks**
5.7 Train the staff in ATFM measures for airports			E	Permanent
5.8 Monitor the training of the ATM community			E	Permanent
6. Final implementation decision				
6.1 Identify and review factors that may affect the implementation decision		SAM/IG/6	ATFM/IG	
6.2 Declare the pre-operational implementation in the defined area		TBD	E	
6.3 Declare the final operational implementation in the defined area		TBD	E	
7. Monitor system performance	**SAM/IG/7**	**SAM/IG/8**		
7.1 Draft the ATFM post-implementation follow-up programme at airports	SAM/IG/6	SAM/IG/7	ATFM/IG	
7.2 Implement the ATFM post-implementation follow-up programme at airports	SAM/IG/7	SAM/IG/X	E	
Tentative pre-operational implementation date		**N/A**	**Oct 2010**	
Tentative definitive implementation date		**N/A**	**Dec 2010**	

Note:

E	States
SAM/IG	SAM Implementation Group
ATFM/IG	ATFM Implementation Group
OR	Regional Office

ACTION PLAN FOR ATFM IMPLEMENTATION IN THE SAM REGION				
B- AIRSPACE				
Task description	**Start**	**End**	**Responsible party(designate individual or office in charge)**	**Remarks**
1. Airspace demand and capacity analysis				
1.1 Analyse the methodology to estimate ATC sector airspace capacity presented by Brazil	Jun 2008	SAM/IG/2		**Finalised**
1.2 Prepare an airspace demand survey	TBD	TBD		
1.3 Attend the course on Airspace Capacity Estimate	**TBD**	**TBD**		
1.4 Carry out the States estimate airspace ATC sector capacity at the major airports	**TBD**	**TBD**		
1.5. Identify airspace sectors where demand sometimes exceeds capacity, including simulations by the States, if necessary	**TBD**	**TBD**		
1.6 Identify factors affecting airspace demand and capacity in order to optimise the use of existing capacity, including simulations if necessary and present conclusions	**TBD**	**TBD**		
2. Coordination with the ATM community	**Sep 2008**	**Sep 2010**		
2.1Coordinate with the ATM community considers the implementation of ATFM in the airspace	Sep 2008	Aug 2010		
2.2 Review the flexible use of restricted, dangerous and prohibited airspaces.		SAM/IG/6	E	Consider the results of the civil/military coordination meeting carried out in Montreal in October 2009.
3. Infrastructure and database	**TBD**	**Dec 2013**		
3.1 Send requirements to the Automation Group, as stipulated in Appendix B of the ATFM CONOPS	TBD	TBD		
3.2 Coordinate implementation activities with the Automation Group	N/A	Dec 2013		
4. Policy, standards, and procedures	**TBD**	**Jun 2013**		
4.1 Develop ATFM policies, taking into account the	**TBD**	**TBD**		

ACTION PLAN FOR ATFM IMPLEMENTATION IN THE SAM REGION B- AIRSPACE				
Task description	**Start**	**End**	**Responsible party(designate individual or office in charge)**	**Remarks**
objectives and principles established in the CAR/SAM ATFM CONOPS				
4.2 Develop Draft CDM Manual		SAM/IG/5	RO Regional Project RLA/06/901	
5. Training	**TBD**	**May 2013**		
5.1 Train the team on airspace data collection	Jun 2009			Permanent
5.2 Air Traffic Flow Management Course/Workshop			Brazil	Hosted by RLA/06/901
5.3 Train personnel in ATFM strategic measures for airspace	**TBD**	TBD		
5.4 Prepare plans and ATFM training material	TBD	TBD		
5.5 Conduct training of personnel involved.				
6. Final implementation decision	**N/A**	**Sep 2013**		
6.1 Analyse factors affecting the implementation decision	**N/A**	**TBD**		
6.2 Declare pre-operational implementation in the area defined	**N/A**	**TBD**		
6.3 Declare definitive operational implementation in the area defined	**N/A**	**TBD**		
7. Monitor system performance	**TBD**	**N/A**		
7.1 Draft ATFM post-implementation follow-up programme	TBD	Aug 2013		
7.2 Implement ATFM post-implementation follow-up programme	Dec 2013	N/A		
Tentative pre-operational implementation date	**N/A**	**Jul 2013**		
Tentative definitive implementation date	**N/A**	**Dec 2013**		

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Agenda Item 6: Assessment of operational requirements in order to determine the implementation of improvements to communications, navigation and surveillance (CNS) capabilities for en-route and terminal area operations

Action plans for CNS improvements

6.1 The Meeting took note of the Action Plans for the Improvement of CNS Systems to meet Short- and Medium-Term Operational Requirements for En Route and Terminal Area Operations drafted by the SAM States.

6.2 The action plans presented by the States analyze the status of conventional communications, navigation and surveillance equipment that support air navigation services, and the actions foreseen to improve the CNS systems in the short and medium term.

6.3 The Meeting took note that all SAM States had presented their action plans, with the exception of Colombia, French Guiana and Panama. In this regard, the Meeting urged these States and Territory to present their action plans for CNS improvements. Accordingly, the following conclusion was formulated:

Conclusion SAM/IG/4-7 - Drafting of pending Action Plans for the Improvement of CNS Systems to meet Short- and Medium-Term Operational Requirements for En Route and Terminal Area Operations

That the aeronautical administrations of Colombia, French Guiana and Panama draft their respective action plans for the improvement of CNS systems, following the model action plan presented at the SAM/IG/3 meeting (Appendix A to agenda item 6) and send them to the ICAO SAM Regional Office no later than **30 November 2009**.

6.4 The Meeting considered that the action plans submitted will be very useful for the regional implementation planning of the various CNS systems. It also considered that the action plans for the implementation of CNS improvements will support PBN implementation, the optimization of ATS routes and the ATFM in the SAM Region.

6.5 The Meeting agreed that the action plans for CNS improvements are living documents and, thus, require frequent updating. In this respect, the Meeting stated that, initially, the updating of the plans could be carried out twice a year, coinciding with the dates of the SAM/IG meetings. Changes made by the States to their action plans would be reported at those meetings.

6.6 The Meeting considered that the action plans for CNS improvements should be posted on the ICAO SAM Regional Office website, and that consideration should be given to the possibility of updating them on-line. The Secretariat would be in charge of analyzing this, and present the results at the SAM/IG/5 Meeting.

6.7 In this regard and in view of the above, the Meeting formulated the following conclusion:

Conclusion SAM/IG/4-8 - Updating of the Action Plans for the improvement of CNS Systems to meet Short- and Medium-Term Operational Requirements for En Route and Terminal Area Operations

That SAM States, with the aim of keeping updated the Action Plans for the improvement of CNS Systems to meet Short- and Medium-Term Operational Requirements for En Route and Terminal Area Operations, present their updated versions twice a year, if any, in the dates corresponding to the holding of SAM/IG meetings.

Interconnection of AMHS systems

6.8 As follow-up to the activities scheduled in the Action Plan for the Interconnection of AMHS Systems in the SAM Region, drafted at the SAM/IG/2 Meeting, the Meeting was presented with an initial guide for AMHS interconnection. In this respect, the Meeting considered that this guidance would be of great use for the interconnection of AMHS in the Region.

6.9 The guide has two parts: the first, related with prior functional trials to ensure end-to-end inter-operability between two AMHS in the SAM Region so as not to disturb real traffic and avoid unnecessary inconveniences to the operational systems. The second part defines the interconnection, the ATN addressing and AMHS scenarios, and the appropriate procedures for the operational integration of AMHS, on the basis of the national deployment of user terminals in each State and of the AMHS interconnection guide. **Appendix A** to this Agenda Item contains the guide for AMHS interconnection.

6.10 The Meeting considered that the guide should be reviewed by all States of the Region, and then sent to the ICAO SAM Regional Office by 15 December 2009. It is expected that the guide, once reviewed, will serve as material for the interconnection of AMHS. Therefore, the Meeting formulated the following Conclusion:

Conclusion SAM/IG/4-9 - Review of the guide for the interconnection of AMHS

That SAM States review the guide for the interconnection of AMHS in Appendix A to this part of the Report and, once reviewed, send their comments to the ICAO SAM Regional Office no later than **15 December 2009**.

6.11 The Meeting took note of the Memorandum of Understanding (MoU) for the interconnection of AMHS drafted during the ATM/CNS Multilateral Meeting between Argentina, Bolivia, Brazil, Paraguay and Uruguay (Lima, Peru, 14 to 18 September 2009). During the multilateral meeting, AMHS interconnection MoUs were drafted and signed between Argentina-Brazil, Argentina-Paraguay and Brazil-Paraguay. With regard to the MoU between Brazil-Paraguay, during the SAM/IG/4 Meeting the delegates of Brazil and Paraguay made an observation as to the need to amend some paragraphs in said document. The Meeting noted that the amendment to the document would be carried out through the coordinators of the management group for AMHS interconnection.

6.12 Also, the Meeting took note that, for the interconnection of AMHS, the following material was available:

a) AMHS addressing plan;
b) IPV4 addressing plan;
c) Regional plan for the implementation of ATN ground applications and routers;

d) Guide for the implementation of national digital networks in IP protocol to support current and future aeronautical applications;
e) Guide for the operational interconnection of AMHS in the SAM Region; and
f) Model Memorandum of Understanding (MoU) for the interconnection AMHS, presented in **Appendix B** to this part of the Report.

6.13 Taking into account that other AMHS have been implemented in the SAM Region, in Chile, Colombia and Peru, the Meeting prepared an action plan for AMHS interconnection between:

a) Argentina-Chile;
b) Argentina-Peru;
c) Brazil-Colombia;
d) Brazil-Peru;
e) Chile-Peru; and
f) Colombia-Peru.

6.14 The plan specifies the technical activities necessary for the interconnection of AMHS. **Appendix C** to this part of the Report presents a model action plan for AMHS interconnection between the aforementioned States.

6.15 In this regard, the Meeting formulated the following Conclusion:

Conclusion SAM/IG/4-10 - AMHS interconnection between Argentina-Chile, Argentina-Peru, Brazil-Colombia, Brazil-Peru, Chile-Peru and Colombia-Peru

The respective administrations are urged to operationally interconnect AMHS between Argentina-Chile, Argentina-Peru, Brazil-Colombia, Brazil-Peru, Chile-Peru and Colombia-Peru, and that, to that end, they:

a) Use the model Memorandum of Understanding (MoU) shown in Appendix B to this part of the report;

b) Complete the information in the MoU, taking into account the action plan for AMHS interconnection in Appendix C to this part of the Report;

c) Present the MoU to the ICAO SAM Regional Office by **15 December 2009**; and

d) Sign the model MoU at the SAM/IG/5 Meeting.

SAM ATN study

6.16 The Meeting, taking into account the expected increase of new services in the short and medium-term (AMHS interconnection, exchange of flight plans and radar data, among others), considered the need to conduct a study on a SAM ATN network including the REDDIG and, possibly, a regional ground network.

6.17 The study would consist of an analysis of the current REDDIG digital network, based on bandwidth requirements for the implementation of new services (ATN ground applications, exchange of automated systems), an analysis of the current REDDIG infrastructure and the technological changes required, and the architecture of a SAM ground network that, together with REDDIG, would represent the ATN for the SAM Region.

6.18 In this respect, the Meeting considered that, in order to carry out this study, a 15-day mission would be required from a CNS expert with ample experience in digital network implementation. The result of the study would be presented at the SAM/IG/5 meeting.

SAM Region VOR/DME coverage data base

6.19 The Meeting took note of the drafting of a data base with information on calculated SAM VOR and DME radio navigation aid coverage to meet navigation specifications and, above all, the navigation reversal mode in the event of loss of GNSS systems.

6.20 The data base presented to the Meeting did not contain the calculated coverage of all VOR/DME radio navigation aids in the Region. In this respect, the Meeting agreed that the coverage of the remaining radio navigation aid calculated coverage should be completed and that presented at the SAM/IG/5 meeting. For this task, the services of a CNS expert in coverage calculation would be required for one week.

6.21 The Meeting took note of a preliminary study of VOR/DME and DME/DME coverage to support RNAV 5 in the Santiago-Lima and Lima-Quito flows.

6.22 In this respect, the Meeting analyzed the information presented and considered necessary to continue the VOR/DME and DME/DME analysis for all the traffic flows in the SAM Region.

ADS B trials

6.23 As follow-up to the action plan for the implementation of ADS B trials drafted at the SAM/IG/2 meeting, the Meeting took note of the results of the ADS B trials held in Lima, Peru, using a Thales ADS B receiving station, family AS-68X, series AS680. **Appendix D** to this Agenda Item shows the results of the trials carried out.

6.24 The Meeting considered that the results of all ADS B trials to be conducted in the Region should be disseminated regionally. In this regard, Argentina, Chile and Peru informed they would be carrying out ADS B trials in 2010.

6.25 A seminar on surveillance and ATM automation has been scheduled to be held at the end of 2010 and, in this respect, the Meeting considered it convenient that the results of all ADS B trials carried out be presented at that seminar. The seminar would have a specific session on ADS B. The next meeting of the Regional Project RLA/06/901 Coordination Committee (RCC/3) would be requested to approve the granting of a fellowship for each project member State, for participation in this event. Thanks to the kind offer of Argentina, the event would be carried out in said State.

APPENDIX A

Guide for the Operational Interconnection of AMHS Systems in the SAM Region

Project RLA/06/901

INDEX

REFERENCE DOCUMENTS

1. EUR AMHS 4.0 Manual
2. EUR AMHS Documentation, PRMD and Addressing Registry
3. Fifth ATN Task Force Meeting Report
4. SAM AMHS Implementation Plan
5. SAM AMHS Addressing Scheme

LIST OF ACRONYMS

ADMD	Administrative Domain
AFTN	Aeronautical Fixed Telecommunications Network
AMHS	Aeronautical Message Handling System
ATN	Aeronautical Telecommunications Network
ATS	Air Traffic Service
BIS	Boundary Intermediate System
CAAS	Common AMHS Addressing Scheme
CARSAM	The Caribbean - South America
CH	AFTN Channel
CN	Common Name
DL	Distribution List
Dr	Delivery Report
DS	Directory Service
EUR	Europe - Eurocontrol
IP	Internet Protocol
IPM	Personal Inter Message
IUT	Implementation under test
MTA	Message Transfer Agent
MTCU	Message Transfer and Conversion Unit
NAT	Network Address Translation
NDR	Non Delivery Report
PRMD	Primary Domain
RE	Remote
REDDIG	South American Digital network
RN	Read Notification
SS ACK	Message of recognition
SARP	Standard and Recommended Practices
TSAP	Transmission Site Point Access
UA	User Agent

INTRODUCTION

1.1 **Purpose**

1.1.1 The purpose of this document is:

1.1.1.1 To present to the SAM States *Orientation Guide for AMHS Systems operative Integration* (for any case these systems works nation wide partially or totally), by means of the connection of their respective MTA and, optionally, its Directory services (DS).

1.1.1.2 To define, in first place, the previous functional tests, in order to assure end to end interoperability between two AMHS systems, and to not disturb real traffic, assuring with it to avoid unnecessary disadvantages in the operational systems (First Part of the document).

1.1.1.3 These tests were established once the AMHS approval testing were successfully completed (i.e. Appendix D, EUR AMHS Manual, Version 4.0, Eurocontrol), through which the compliance of all systems under test to the AMHS technical specifications has been demonstrated.

1.1.1.4 Defining, in second place, the interconnection scenarios, ATN and AMHS address, and the appropiate procedures for AMHS operative integration, based on the national UAs' deploy in each State (Second Part of the document).

1.2 **Document structure**

1.2.1 This Document consists of two parts, highly differentiated but complementary: *First Part (Integration Tests):* This partial has been based from the Appendix E of EUR AMHS Manual, version 4.0, Eurocontrol, with the objective to help the States to have a reference document for the accomplishment of AMHS tests, *essential action to be developed before any attempt of operative integration*:

1.2.1.1 With other States, so that it allows the bilateral verification of systems operation, like a preparation to later Operative Integration, and

1.2.1.2 Within the same Administration, if it has decided to count with more of one MTA in operation.

1.2.2 For this Part has been had the following points:

1.2.2.1 The test atmosphere to be used.

1.2.2.2 The defined address plan to be implemented.

1.2.2.3 The general description of bilateral test procedures, with the subdivisions for each AMHS functional area. Each procedure of the test appears of a structured way that consists of:

a) The defined test criteria,

b) A brief description of the scenario,

c) The reference to the corresponding SARP,

d) The reference to similar tests made by Eurocontrol.

1.2.3 *Second Part (Operative Integration):* this part tries to help to the administrations in operative integration between States, it being developed:

1.2.3.1 The aspects to be considered.

1.2.3.2 The possible scenarios for operative integration.

1.2.3.3 The preparatory phase.

1.2.3.4 The necessary agreements.

1.2.3.5 The operational phase.

1.2.4 **References**

1.2.4.1 EUR AMHS Manual.

1.2.4.2 Manual of Technical Provisions for the Aeronautical Telecommunication Network (ATN), Sub-Volume III (Doc 9705).

1.2.4.3 Manual on Detailed Technical Specifications for the Aeronautical Telecommunication Network (ATN) using ISO/OSI Standards and Protocols, Part II-B (Doc 9880).

2. FIRST PART (AMHS INTERCONNECTION TESTS)

2.1 Test Identification Scheme

2.1.1 Each Interoperability Test procedure has an identifier in the form *Itxnn* where*;*

2.1.1.1 **IT** is an acronym for Interoperability Test,

2.1.1.2 ***x*** is a number identifying the test group, and

2.1.1.3 ***nn*** is a consecutive number identifying the individual test procedure.

2.1.2 The bilateral test groups consist of tests using messages specifically generated by IUTs for trials. The following six groups have been identified:

2.1.2.1 testing of submission, transfer and delivery operations (x=1),

2.1.2.2 testing of gateway operations converting a user message from AFTN to AMHS (x=2),

2.1.2.3 testing of gateway operations converting a user message from AMHS to AFTN (x=3),

2.1.2.4 testing of gateway operations converting a user message from AFTN to AMHS and back to AFTN (x=4),

2.1.2.5 testing of gateway operations – special cases (x=5), and

2.1.2.6 testing of stress traffic situations (x=6).

2.2 Application infrastructure

2.2.1 Both AMHS Implementations Under Test (IUTs) are complete systems constituted by AFTN, AMHS and AFTN/AMHS gateway components, with corresponding AFTN and AMHS user terminals and supervision positions, as decided locally by the corresponding organization.

2.2.2 In each IUT, an AMHS User Agent is used in submission and delivery tests. Gateway tests involve an AFTN user terminal. The use of the Monitor & Control Position is required in order to observe the outcome of the conversion processes, especially in out-of-line situations.

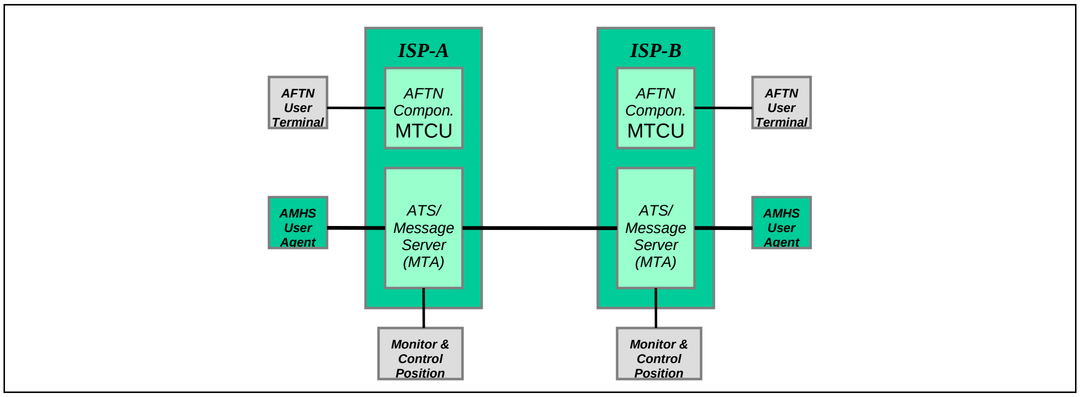


Figure 1: AMHS Interoperability Test Environment

2.2.3 Figure 1 shows the test environment used for AMHS interoperability tests. Both IUTs will be interconnected via AMHS transfer ports supporting the X.400/P1 protocol over a TCP/IP/LAN.

Note. – In Figure 1 the AFTN Terminal is directly connected to the AFTN Component in an abstract way. There may exist different implementations with an AFTN component only connected to an AFTN switch or integrated AFTN/AMHS switches. For the interoperability tests it does not matter whether the AFTN Terminal is connected directly or indirectly.

2.2.4 The components of the test environment as depicted in are involved in the test procedures in following way:

2.2.4.1 ***Submission, Transfer and Delivery operation tests (AMHS => AMHS) (x=1):***

AMHS User Agent => ATS Message Server => ATS Message Server => AMHS User Agent

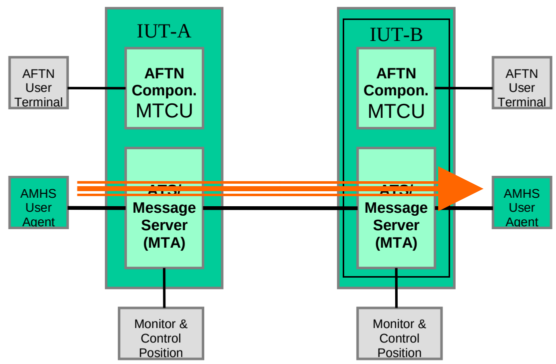


Figure 2: UA to UA (IUT-A to IUT-B)

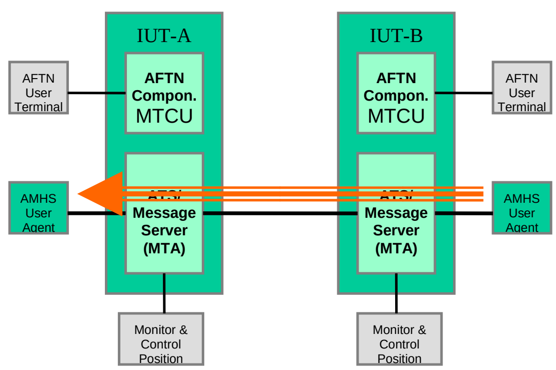


Figure 3: UA to UA (IUT-B to IUT-A)

2.2.4.2 ***AMHS / AFTN gateway tests (AFTN => AMHS) (x=2):***

AFTN Terminal => Gateway and ATS Message Server => UA

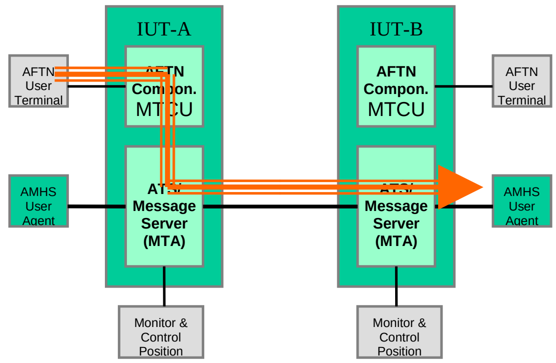


Figure 4: AFTN Terminal to UA (IUT-A to IUT-B)

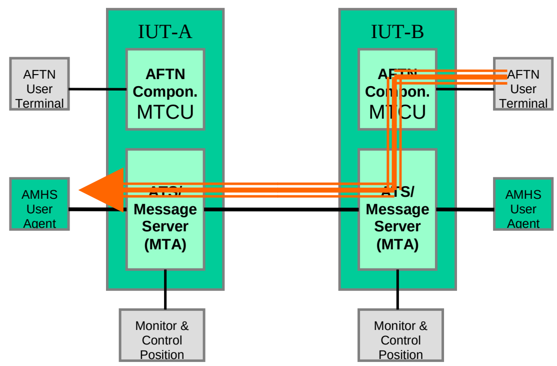


Figure 5: AFTN Terminal to UA (IUT-B to IUT-A)

2.2.4.3 ***AMHS / AFTN gateway tests (AMHS => AFTN) (x=3):***

UA => ATS Message Server and Gateway => AFTN Terminal

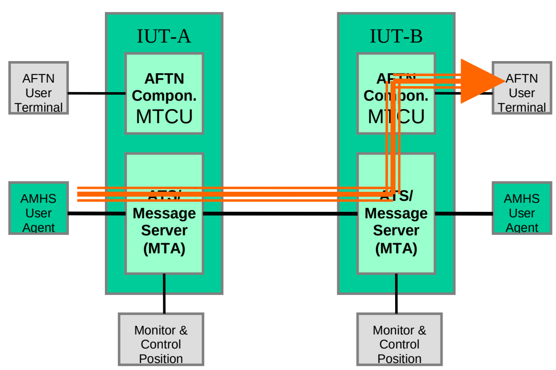


Figure 6: UA to AFTN Terminal (IUT-A to IUT-B)

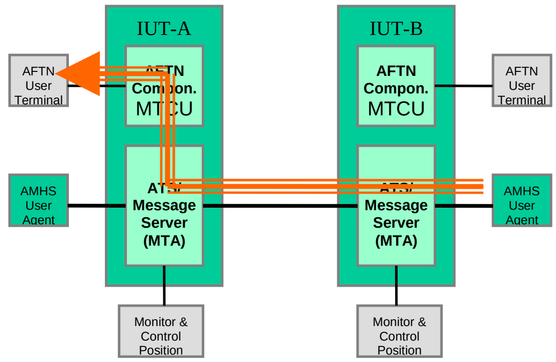


Figure 7: UA to AFTN Terminal (IUT-B to IUT-A)

2.2.4.4 ***AMHS / AFTN gateway tests (AFTN => AMHS => AFTN) (x=4):***

AFTN Terminal => Gateway => ATS Message Servers => Gateway => AFTN Terminal

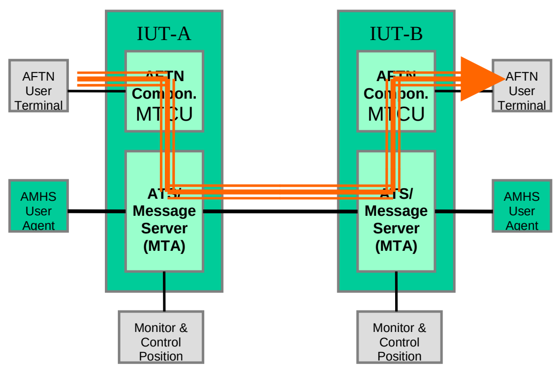


Figure 8: AFTN Terminal to AFTN Terminal (IUT-A to IUT-B)

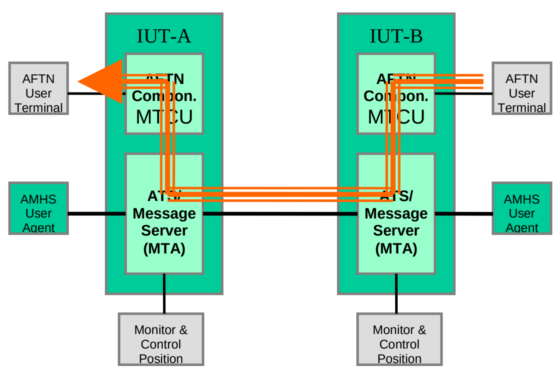


Figure 9: AFTN Terminal to AFTN Terminal (IUT-B to IUT-A)

2.2.4.5 ***Gateway Operations – special case scenarios (x=5)***

a) For the special case scenarios different combinations of the flows shown above are used.

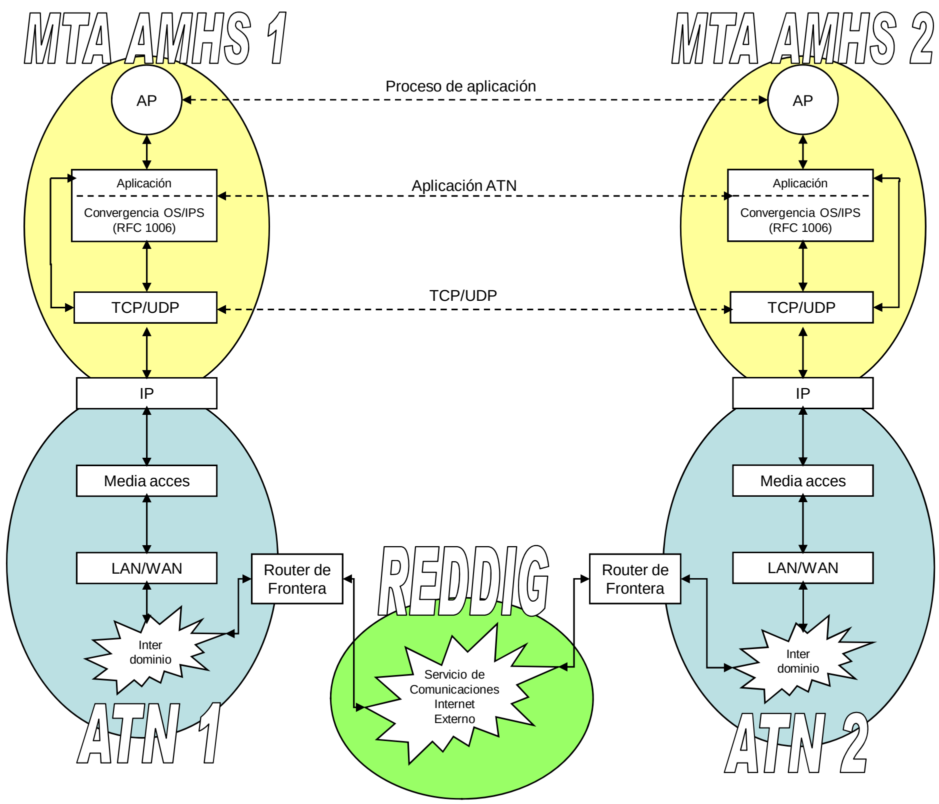
2.2.4.6 ***Stress traffic situations (x=6)***

a) Depending on the stress scenario chosen combinations of the flows shown above are used.

2.3 **Transport infrastructure**

2.3.1 To perform the bilateral interoperability tests, an underlying infrastructure for message transport between the two IUTs has to be agreed.

2.3.2 In the case of the bilateral test between Spain and Argentina the following infrastructure is proposed:



2.4 IP Address

2.4.1 Agreed with established in regional frame, it should be use the following IP address for link doors, in accord with states pairs:

Network	Link				
	Number	Subnetwork	Connected Routers	Addresses to Use	
10.15.224.0 / 19	1	10.15.224.0 / 30	Argentina - Bolivia	-	10 . 15 . 224 . 0 / 30
				Argentina	10 . 15 . 224 . 1 / 30
				Bolivia	10 . 15 . 224 . 2 / 30
				-	10 . 15 . 224 . 3 / 30
	2	10.15.224.4 / 30	Argentina - Chile	-	10 . 15 . 224 . 4 / 30
				Argentina	10 . 15 . 224 . 5 / 30
				Chile	10 . 15 . 224 . 6 / 30
				-	10 . 15 . 224 . 7 / 30
	3	10.15.224.8 / 30	Argentina - Paraguay	-	10 . 15 . 224 . 8 / 30
				Argentina	10 . 15 . 224 . 9 / 30
				Paraguay	10 . 15 . 224 . 10 / 30
				-	10 . 15 . 224 . 11 / 30
	4	10.15.224.12 / 30	Argentina - Peru	-	10 . 15 . 224 . 12 / 30
				Argentina	10 . 15 . 224 . 13 / 30
				Peru	10 . 15 . 224 . 14 / 30
				-	10 . 15 . 224 . 15 / 30
	5	10.15.224.16 / 30	Argentina - Uruguay	-	10 . 15 . 224 . 16 / 30
				Argentina	10 . 15 . 224 . 17 / 30
				Uruguay	10 . 15 . 224 . 18 / 30
				-	10 . 15 . 224 . 19 / 30
	7	10.15.224.24 / 30	Brazil - Colombia	-	10 . 15 . 224 . 24 / 30
				Brazil	10 . 15 . 224 . 25 / 30
				Colombia	10 . 15 . 224 . 26 / 30
				-	10 . 15 . 224 . 27 / 30
	8	10.15.224.28 / 30	Brazil - Guyana	-	10 . 15 . 224 . 28 / 30
				Brazil	10 . 15 . 224 . 29 / 30
				Guyana	10 . 15 . 224 . 30 / 30
				-	10 . 15 . 224 . 31 / 30
	9	10.15.224.32 / 30	Brazil – French Guiana	-	10 . 15 . 224 . 32 / 30
				Brazil	10 . 15 . 224 . 33 / 30
				French Guiana	10 . 15 . 224 . 34 / 30
				-	10 . 15 . 224 . 35 / 30
	10	10.15.224.36 / 30	Brazil - Peru	-	10 . 15 . 224 . 36 / 30
				Brazil	10 . 15 . 224 . 37 / 30
				Peru	10 . 15 . 224 . 38 / 30
				-	10 . 15 . 224 . 39 / 30
	11	10.15.224.40 / 30	Brazil - Surinam	-	10 . 15 . 224 . 40 / 30
				Brazil	10 . 15 . 224 . 41 / 30
				Surinam	10 . 15 . 224 . 42 / 30
				-	10 . 15 . 224 . 43 / 30
	12	10.15.224.44 / 30	Brazil - Venezuela	-	10 . 15 . 224 . 44 / 30
				Brazil	10 . 15 . 224 . 45 / 30

Network	Link				
	Number	**Subnetwork**	**Connected Routers**	**Addresses to Use**	
				Venezuela	10 . 15 . 224 . 46 / 30
				-	10 . 15 . 224 . 47 / 30
	16	10.15.224.60 / 30	Brazil - Argentina	-	10 . 15 . 224 . 60 / 30
				Brazil	10 . 15 . 224 . 61 / 30
				Argentina	10 . 15 . 224 . 62 / 30
				-	10 . 15 . 224 . 63 / 30
	17	10.15.224.64 / 30	Brazil - Bolivia	-	10 . 15 . 224 . 64 / 30
				Brazil	10 . 15 . 224 . 65 / 30
				Bolivia	10 . 15 . 224 . 66 / 30
				-	10 . 15 . 224 . 67 / 30
	18	10.15.224.68 / 30	Brazil - Paraguay	-	10 . 15 . 224 . 68 / 30
				Brazil	10 . 15 . 224 . 69 / 30
				Paraguay	10 . 15 . 224 . 70 / 30
				-	10 . 15 . 224 . 71 / 30
	19	10.15.224.72 / 30	Brazil - Uruguay	-	10 . 15 . 224 . 72 / 30
				Brazil	10 . 15 . 224 . 73 / 30
				Uruguay	10 . 15 . 224 . 74 / 30
				-	10 . 15 . 224 . 75 / 30
	21	10.15.224.80 / 30	Chile - Peru	-	10 . 15 . 224 . 80 / 30
				Chile	10 . 15 . 224 . 81 / 30
				Peru	10 . 15 . 224 . 82 / 30
				-	10 . 15 . 224 . 83 / 30
	23	10.15.224.88 / 30	Colombia - Ecuador	-	10 . 15 . 224 . 88 / 30
				Colombia	10 . 15 . 224 . 89 / 30
				Ecuador	10 . 15 . 224 . 90 / 30
				-	10 . 15 . 224 . 91 / 30
	24	10.15.224.92 / 30	Colombia - Peru	-	10 . 15 . 224 . 92 / 30
				Colombia	10 . 15 . 224 . 93 / 30
				Peru	10 . 15 . 224 . 94 / 30
				-	10 . 15 . 224 . 95 / 30
	25	10.15.224.96 / 30	Colombia - Venezuela	-	10 . 15 . 224 . 96 / 30
				Colombia	10 . 15 . 224 . 97 / 30
				Venezuela	10 . 15 . 224 . 98 / 30
				-	10 . 15 . 224 . 99 / 30
	26	10.15.224.100 / 30	Ecuador - Peru	-	10 . 15 . 224 . 100 / 30
				Ecuador	10 . 15 . 224 . 101 / 30
				Peru	10 . 15 . 224 . 102 / 30
				-	10 . 15 . 224 . 103 / 30
	27	10.15.224.104 / 30	Ecuador - Venezuela	-	10 . 15 . 224 . 104 / 30
				Ecuador	10 . 15 . 224 . 105 / 30
				Venezuela	10 . 15 . 224 . 106 / 30
				-	10 . 15 . 224 . 107 / 30
	28	10.15.224.108 / 30	French Guiana - Surinam	-	10 . 15 . 224 . 108 / 30
				French Guiana	10 . 15 . 224 . 109 / 30
				Surinam	10 . 15 . 224 . 110 / 30
				-	10 . 15 . 224 . 111 / 30
	29	10.15.224.112 / 30	Guyana - CCAR	-	10 . 15 . 224 . 112 / 30

Network	Link				
	Number	Subnetwork	Connected Routers	Addresses to Use	
				Guyana	10 . 15 . 224 . 113 / 30
				CCAR (Piarco)	10 . 15 . 224 . 114 / 30
				-	10 . 15 . 224 . 115 / 30
	30	10.15.224.116 / 30	Guyana - Surinam	-	10 . 15 . 224 . 116 / 30
				Guyana	10 . 15 . 224 . 117 / 30
				Surinam	10 . 15 . 224 . 118 / 30
				-	10 . 15 . 224 . 119 / 30
	31	10.15.224.120 / 30	Guyana - Venezuela	-	10 . 15 . 224 . 120 / 30
				Guyana	10 . 15 . 224 . 121 / 30
				Venezuela	10 . 15 . 224 . 122 / 30
				-	10 . 15 . 224 . 123 / 30
	33	10.15.224.128 / 30	Peru - Bolivia	-	10 . 15 . 224 . 128 / 30
				Peru	10 . 15 . 224 . 129 / 30
				Bolivia	10 . 15 . 224 . 130 / 30
				-	10 . 15 . 224 . 131 / 30
	34	10.15.224.132 / 30	Peru - Colombia	-	10 . 15 . 224 . 132 / 30
				Peru	10 . 15 . 224 . 133 / 30
				Colombia	10 . 15 . 224 . 134 / 30
				-	10 . 15 . 224 . 135 / 30
	35	10.15.224.136 / 30	Peru - Venezuela	-	10 . 15 . 224 . 136 / 30
				Peru	10 . 15 . 224 . 137 / 30
				Venezuela	10 . 15 . 224 . 138 / 30
				-	10 . 15 . 224 . 139 / 30
	36	10.15.224.140 / 30	Surinam - Venezuela	-	10 . 15 . 224 . 140 / 30
				Surinam	10 . 15 . 224 . 141 / 30
				Venezuela	10 . 15 . 224 . 142 / 30
				-	10 . 15 . 224 . 143 / 30
	37	10.15.224.144 / 30	Venezuela - CAR	-	10 . 15 . 224 . 144 / 30
				Venezuela	10 . 15 . 224 . 145 / 30
				CAR (San Juan)	10 . 15 . 224 . 146 / 30
				-	10 . 15 . 224 . 147 / 30
	39	10.15.224.152 / 30	Venezuela - Trinidad y Tobago	-	10 . 15 . 224 . 152 / 30
				Venezuela	10 . 15 . 224 . 153 / 30
				Trinidad y Tobago	10 . 15 . 224 . 154 / 30
				-	10 . 15 . 224 . 155 / 30
	40	10.15.224.156 / 30	Vacant	-	10 . 15 . 224 . 156 / 30
				-	10 . 15 . 224 . 157 / 30
				-	10 . 15 . 224 . 158 / 30
				-	10 . 15 . 224 . 159 / 30
	-	10.15.224.160 / 30	Vacant	-	10 . 15 . 224 . 160 / 30
				-	10 . 15 . 224 . 161 / 30
				-	10 . 15 . 224 . 162 / 30
				-	10 . 15 . 224 . 163 / 30
	-	10.15.224.164 / 30	Vacant	-	10 . 15 . 224 . 164 / 30
				-	10 . 15 . 224 . 165 / 30
				-	10 . 15 . 224 . 166 / 30

<table>
<tr><th rowspan="2">Network</th><th colspan="5">Link</th></tr>
<tr><th>Number</th><th>Subnetwork</th><th>Connected Routers</th><th colspan="2">Addresses to Use</th></tr>
<tr><td rowspan="13"></td><td></td><td></td><td></td><td>-</td><td>10 . 15 . 224 . 167 / 30</td></tr>
<tr><td rowspan="4">-</td><td rowspan="4">-</td><td rowspan="4">-</td><td>-</td><td>-</td></tr>
<tr><td>-</td><td>-</td></tr>
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<tr><td rowspan="4">-</td><td rowspan="4">-</td><td rowspan="4">-</td><td>-</td><td>-</td></tr>
<tr><td>-</td><td>-</td></tr>
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<tr><td>-</td><td>-</td></tr>
<tr><td rowspan="4">2048
(last)</td><td rowspan="4">10.15.31.252 / 30</td><td rowspan="4">Vacant</td><td>-</td><td>10 . 15 . 224 . 252 / 30</td></tr>
<tr><td>-</td><td>10 . 15 . 224 . 253 / 30</td></tr>
<tr><td>-</td><td>10 . 15 . 224 . 254 / 30</td></tr>
<tr><td>-</td><td>10 . 15 . 224 . 255 / 30</td></tr>
</table>

2.4.2 With respect to IP addresses initially assigned to each State, they are attached as Appendix A.

2.5 Default names and passwords

2.5.1 The following entries and/or parameter shall be agreed between the test partners. Preferred the default values should be used.

2.5.2 Default MTA names and passwords

IUT A: Name of the aeronautical administration- State A.
IUT B: Name of the aeronautical administration- State B.

IUT	MTA name	Remarks
IUT-A		
IUT-B		

Table 1: Default MTA names

IUT	Password	Remarks
IUT-A		
IUT-B		

Table 2: Default passwords

2.5.3 TSAP addresses

IUT A: Name of the aeronautical administration- State A.
IUT B: Name of the aeronautical administration- State B.

IUT	TSAP address	Remarks
IUT-A		
IUT-B		

Table 3: TSAP addresses

2.5.4 MTA Addresses

IUT A: Name of the aeronautical administration- State A.
IUT B: Name of the aeronautical administration- State B.

ISP	IP address	Remarks
IUT-A	MTA address, in agree with IP regional addressing plan	
IUT-B	MTA address, in agree with IP regional addressing plan	

Table 4: IP Address

2.6 User addresses

2.6.1 To meet the scope of testing, the test-address space used by AMHS Interoperability Testing should include, for each IUT, the respective AFTN and AMHS addresses and the corresponding AMHS PRMD.

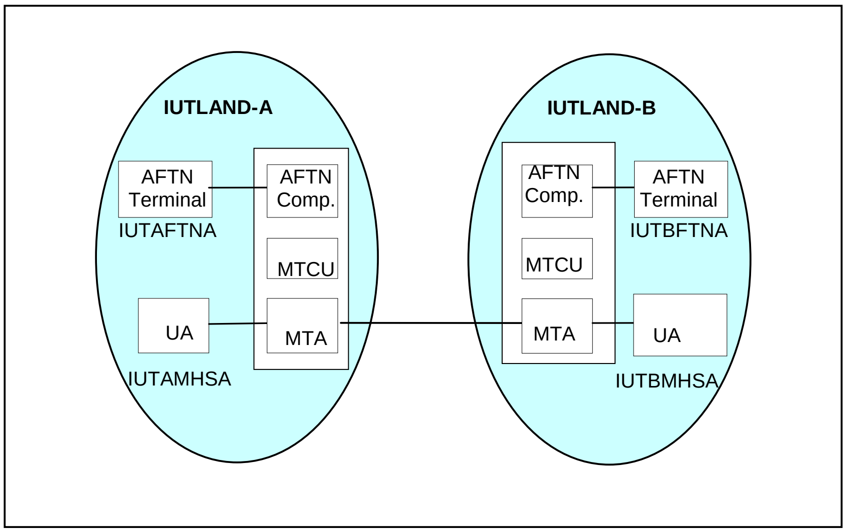


Figure 10: Addressing Plan

2.6.2 The original, operational AMHS and AFTN addresses assigned to the COM Centre could be used as test addresses for each IUT. To distinguish between operational and test addresses it is recommended to use alternatively, a generic address space taken from fictitious PRMD/AFTN countries IUTLAND-A and IUTLAND-B.

2.6.3 This includes generic user addresses IUTAFTNA and IUTAMHSA for IUTLAND-A as well as IUTBFTNA and IUTBMHSA for IUTLAND-B, which may be mapped either according to the CAAS with multiple "O" values.

2.6.4 The following tables show the generic address space assigned to the two IUTs and a third IUT if trilateral network tests are performed.

CAAS (preferred) – single "O"	CAAS – multiple "O"	XF
C = XX ADMD = ICAO PRMD = IUTLAND-A O = REGION A OU1 = IUTA CN = IUTAFTNA ... IUTAMHSA	C = XX ADMD = ICAO PRMD = IUTLAND-A O = A-REGION1 OU1 = IUTA CN = IUTAFTNA ... IUTAMHSA O = A-REGION2 OU1 = IUBA CN = IUBAFTNA ... IUBAMHSA	C = XX ADMD = ICAO PRMD = IUTLAND-B O = AFTN OU1 = IUTBFTNA ... IUTBMHSA

Table 5: Generic address spaces of IUTLAND-A

CAAS (preferentemente) –"O" simple	CAAS – "O"multiple	XF
C = XX ADMD = ICAO PRMD = ISPLAND-B O = REGION B OU1 = ISPB CN = ISPBFTNA ... ISPBMHSA	C = XX ADMD = ICAO PRMD = ISPLAND-B O = B-REGION1 OU1 = ISPB CN = ISPBFTNA ... ISPBMHSA O = B-REGION2 OU1 = IUBB CN = IUBBFTNA ... IUBBMHSA	C = XX ADMD = ICAO PRMD = ISPLAND-B O = AFTN OU1 = ISPBFTNA ... ISPBMHSA

Table 6: Generic address spaces of IUTLAND-B

2.7 DL addresses

IUT A: Name of the aeronautical administration- State A.
IUT B: Name of the aeronautical administration- State B.

Distribution List name	Addresses included in the DL	Remarks
IUTADLLO	IUTBFTNA IUTBFTNB IUTBMHSA	
IUTADLRE	IUTAFTNA IUTAFTNB IUTAMHSA	

Table 7: DL addresses of IUT-A

Distribution List name	Addresses included in the DL	Remarks
IUTBDLLO	IUTAFTNA IUTAFTNB IUTAMHSA	
IUTBDLRE	IUTBFTNA IUTBFTNB IUTBMHSA	

Table 8: DL addresses of IUT-B

2.8 AFTN and X.400 Routing Tables

IUT A: Name of the aeronautical administration- State A.
IUT B: Name of the aeronautical administration- State B.

2.8.1 AFTN and X.400 Routing Tables of IUT-A

IUT - A: Name of the aeronautical administration- State A., IUTAFTN* address where IUTA corresponds to the four letters from site indicator corresponding to the site where MTA A is located..

IUT - B: Name of the aeronautical administration- State B., IUTBFTN* address where IUTB corresponds to the four letters from site indicator corresponding to the site where MTA B is located.

AFTN Routing Indicator	Routing direction	Remarks
IUTAFT*	AFTN Terminal	
IUTA*	MTCU	
IUTB*	MTCU	

Table 9: AFTN Routing Table of IUT-A

X.400 Routing Indicator	Routing direction	Remarks
/C=XX/A=ICAO/P=IUTLAND-A /O=A-REGION/OU1=IUTA/CN=IUTAMHSA/	UA IUT-A	If CAAS "single "O" type
/C=XX/A=ICAO/P=IUTLAND-A /O=A-REGION/OU1=IUTA/CN=IUTAMHSB/	UA IUT-A	If CAAS "single "O" type
/C=XX/A=ICAO/P=IUTLAND-A /O=A-REGION/OU1=IUTA/CN=IUTAMHSC/	UA IUT-A	If CAAS "single "O" type
/C=XX/A=ICAO/P=IUTLAND-A /O=AFTN/OU1=IUTAMHSA/	UA IUT-A	If "XF" type
/C=XX/A=ICAO/P=IUTLAND-A /O=AFTN/OU1=IUTAMHSB/	UA IUT-A	If "XF" type
/C=XX/A=ICAO/P=IUTLAND-A /O=AFTN/OU1=IUTAMHSC/	UA IUT-A	If "XF" type
/C=XX/A=ICAO/P=IUTLAND-A	MTCU	
/C=XX/A=ICAO/P=IUTLAND-B	MTA-IUTB-1	
/C=XX/A=ICAO/P=IUTLAND-C	MTA-IUTC-1	
/C=XX/A=ICAO/P=IUTLAND-X	MTA-IUTB-1	

Table 10: X.400 Routing Table of IUT-A

2.8.2 AFTN and X.400 Routing Tables of IUT-B

AFTN Routing Indicator	Routing direction	Remarks
IUTBFT*	AFTN Terminal	
IUTA*	MTCU	
IUTB*	MTCU	
IUTC*	MTCU	

Table 5: AFTN Routing Table of IUT-B

X.400 Routing Indicator	Routing direction	Remarks
/C=XX/A=ICAO/P=IUTLAND-B /O=B-REGION/OU1=IUTB/CN=IUTBMHSA/	UA IUT-B	If CAAS "single "O" type
/C=XX/A=ICAO/P=IUTLAND-B /O=B-REGION/OU1=IUTB/CN=IUTBMHSB/	UA IUT-B	If CAAS "single "O" type
/C=XX/A=ICAO/P=IUTLAND-B /O=B-REGION/OU1=IUTB/CN=IUTBMHSC/	UA IUT-B	If CAAS "single "O" type

X.400 Routing Indicator	Routing direction	Remarks
/C=XX/A=ICAO/P=IUTLAND-B /O=AFTN/OU1=IUTBMHSA/	UA IUT-B	If “XF” type
/C=XX/A=ICAO/P=IUTLAND-B /O=AFTN/OU1=IUTBMHSB/	UA IUT-B	If “XF” type
/C=XX/A=ICAO/P=IUTLAND-B /O=AFTN/OU1=IUTBMHSC/	UA IUT-B	If “XF” type
/C=XX/A=ICAO/P=IUTLAND-B	MTCU	
/C=XX/A=ICAO/P=IUTLAND-A	MTA-IUTA-1	
/C=XX/A=ICAO/P=IUTLAND-X	MTA-IUTC-1	

Table 11: X.400 Routing Table of IUT-B

2.9 Look-up Table

2.9.1 Generic look-up Table for all Implementations Under Test (IUT) (CAAS single “O” type).

AFTN address	**O/R Address (CAAS single “O” type)**
IUTAFTN*	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/
IUTAFTA*	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/
IUTAFTU*	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/ ***Note. – This address has to be unknown and not defined in IUT-A***
IUTAMHSA	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAMHSA/
IUTAMHSB	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAMHSB/
IUTAMHSC	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAMHSC/
IUTADLLO	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTADLLO/
IUTADLRE	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTADLRE/
IUTBFTN*	/C=XX/A=ICAO/P=IUTLAND-B/O=B-REGION/OU1=IUTB/
IUTBFTA*	/C=XX/A=ICAO/P=IUTLAND-B/O=B-REGION/OU1=IUTB/
IUTBFTU*	/C=XX/A=ICAO/P=IUTLAND-B/O=B-REGION/OU1=IUTB/ ***Note. – This address has to be unknown and not defined in IUT-B***
IUTBMHSA	/C=XX/A=ICAO/P=IUTLAND-B/O=B-REGION/OU1=IUTB/CN=IUTBMHSA/
IUTBMHSB	/C=XX/A=ICAO/P=IUTLAND-B/O=B-REGION/OU1=IUTB/CN=IUTBMHSB/
IUTBMHSC	/C=XX/A=ICAO/P=IUTLAND-B/O=B-REGION/OU1=IUTB/CN=IUTBMHSC/
IUTBDLLO	/C=XX/A=ICAO/P=IUTLAND-B/O=B-REGION/OU1=IUTB/CN=IUTBDLLO/
IUTBDLRE	/C=XX/A=ICAO/P=IUTLAND-B/O=B-REGION/OU1=IUTB/CN=IUTBDLRE/
IUTXLOOP	/C=XX/A=ICAO/P=IUTLAND-X/O=X-REGION/OU1=IUTX/CN=IUTXLOOP/

Table 12: Generic look-up table (CAAS single “O” type)

2.9.2 Generic look-up Table for all Implementations Under Test (IUT) ("XF" type)

AFTN address	O/R Address ("XF" type)
IUTAFTN*	/C=XX/A=ICAO/P=IUTLAND-A/
IUTAFTA*	/C=XX/A=ICAO/P=IUTLAND-A/
IUTAFTU*	/C=XX/A=ICAO/P=IUTLAND-A/ ***Note. – This address has to be unknown and not defined in IUT-A***
IUTAMHSA	/C=XX/A=ICAO/P=IUTLAND-A/O=AFTN/OU1=IUTAMHSA/
IUTAMHSB	/C=XX/A=ICAO/P=IUTLAND-A/O=AFTN/OU1=IUTAMHSB/
IUTAMHSC	/C=XX/A=ICAO/P=IUTLAND-A/O=AFTN/OU1=IUTAMHSC/
IUTADLLO	/C=XX/A=ICAO/P=IUTLAND-A/O=AFTN/OU1=IUTADLLO/
IUTADLRE	/C=XX/A=ICAO/P=IUTLAND-A/O=AFTN/OU1=IUTADLRE/
IUTBFTN*	/C=XX/A=ICAO/P=IUTLAND-B/
IUTBFTA*	/C=XX/A=ICAO/P=IUTLAND-B/
IUTBFTU*	/C=XX/A=ICAO/P=IUTLAND-B/ ***Note. – This address has to be unknown and not defined in IUT-B***
IUTBMHSA	/C=XX/A=ICAO/P=IUTLAND-B/O=AFTN/OU1=IUTBMHSA/
IUTBMHSB	/C=XX/A=ICAO/P=IUTLAND-B/O=AFTN/OU1=IUTBMHSB/
IUTBMHSC	/C=XX/A=ICAO/P=IUTLAND-B/O=AFTN/OU1=IUTBMHSC/
IUTBDLLO	/C=XX/A=ICAO/P=IUTLAND-B/O=AFTN/OU1=IUTBDLLO/
IUTBDLRE	/C=XX/A=ICAO/P=IUTLAND-B/O=AFTN/OU1=IUTBDLRE/
IUTXLOOP	/C=XX/A=ICAO/P=IUTLAND-X/O=AFTN/OU1=IUTXLOOP/

Table 13: Generic look-up table ("XF" type)

Note. – There are further possibilities: IUT-A could have XF addressing scheme whilst IUT-B has CAAS, or vice-versa. In such a case, the corresponding table entries should be selected. To simplify matters it is recommended to use CAAS single "O" type or "XF" type only.

2.10 Local AMHS User address book

2.10.1 Local AMHS User address book for UA of all Implementations Under Test (IUT) (CAAS single "O" type).

Nick name	O/R Address (CAAS single "O" type)
IUTAFTNA	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNA/
IUTAFTNB	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNB/
IUTAFTNC	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNC/
IUTAFTND	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTND/
IUTAFTNE	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNE/
IUTAFTNF	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNF/
IUTAFTNG	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNG/
IUTAFTNH	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNH/
IUTAFTNI	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNI/
IUTAFTNJ	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNJ/
IUTAFTNK	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNK/
IUTAFTNL	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNL/
IUTAFTNM	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNM/
IUTAFTNN	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNN/
IUTAFTNO	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNO/

Nick name	O/R Address (CAAS single "O" type)
IUTAFTNP	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNP/
IUTAFTNQ	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNQ/
IUTAFTNR	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNR/
IUTAFTNS	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNS/
IUTAFTNT	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNT/
IUTAFTNU	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNU/
IUTAFTNV	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNV/
IUTAFTNW	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNW/
IUTAFTNX	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNX/
IUTAFTNY	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTNY/
IUTAFTAA	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAA/
IUTAFTAB	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAB/
IUTAFTAC	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAC/
IUTAFTAD	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAD/
IUTAFTAE	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAE/
IUTAFTAF	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAF/
IUTAFTAG	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAG/
IUTAFTAH	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAH/
IUTAFTAI	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAI/
IUTAFTAJ	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAJ/
IUTAFTAK	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAK/
IUTAFTAL	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAL/
IUTAFTAM	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAM/
IUTAFTAN	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAN/
IUTAFTAO	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAO/
IUTAFTAP	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAP/
IUTAFTAQ	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAQ/
IUTAFTAR	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAR/
IUTAFTAS	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAS/
IUTAFTAT	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAT/
IUTAFTAU	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAU/
IUTAFTAV	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAV/
IUTAFTAW	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAW/
IUTAFTAX	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAX/
IUTAFTAY	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTAY/
IUTAFTUU	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAFTUU/
IUTAMHSA	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAMHSA/
IUTAMHSB	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAMHSB/
IUTAMHSC	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTAMHSC/
IUTADLLO	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTADLLO/
IUTADLRE	/C=XX/A=ICAO/P=IUTLAND-A/O=A-REGION/OU1=IUTA/CN=IUTADLRE/
IUTBFTNA	/C=XX/A=ICAO/P=IUTLAND-B/O=B-REGION/OU1=IUTB/CN=IUTBFTNA/
IUTBFTNB	/C=XX/A=ICAO/P=IUTLAND-B/O=B-REGION/OU1=IUTB/CN=IUTBFTNB/
IUTBFTNC	/C=XX/A=ICAO/P=IUTLAND-B/O=B-REGION/OU1=IUTB/CN=IUTBFTNC/
till	**To be continued till**
IUTBFTNY	/C=XX/A=ICAO/P=IUTLAND-B/O=B-REGION/OU1=IUTB/CN=IUTBFTNY/
IUTBFTAA	/C=XX/A=ICAO/P=IUTLAND-B/O=B-REGION/OU1=IUTB/CN=IUTBFTAA/
till	**To be continued till**
IUTBFTAY	/C=XX/A=ICAO/P=IUTLAND-B/O=B-REGION/OU1=IUTB/CN=IUTBFTAY/
IUTBFTUU	/C=XX/A=ICAO/P=IUTLAND-B/O=B-REGION/OU1=IUTB/CN=IUTBFTUU/

Nick name	O/R Address (CAAS single "O" type)
IUTBMHSA	/C=XX/A=ICAO/P=IUTLAND-B/O=B-REGION/OU1=IUTB/CN=IUTBMHSA/
IUTBMHSB	/C=XX/A=ICAO/P=IUTLAND-B/O=B-REGION/OU1=IUTB/CN=IUTBMHSB/
IUTBMHSC	/C=XX/A=ICAO/P=IUTLAND-B/O=B-REGION/OU1=IUTB/CN=IUTBMHSC/
IUTBDLLO	/C=XX/A=ICAO/P=IUTLAND-B/O=B-REGION/OU1=IUTB/CN=IUTBDLLO/
IUTBDLRE	/C=XX/A=ICAO/P=IUTLAND-B/O=B-REGION/OU1=IUTB/CN=IUTBDLRE/
IUTCFTNC	/C=XX/A=ICAO/P=IUTLAND-C/O=C-REGION/OU1=IUTC/CN=IUTCFTNA/
IUTCMHSA	/C=XX/A=ICAO/P=IUTLAND-C/O=C-REGION/OU1=IUTC/CN=IUTCMHSA/
IUTXLOOP	/C=XX/A=ICAO/P=IUTLAND-X/O=X-REGION/OU1=IUTX/CN=IUTXLOOP/

Table 64: Local AMHS User address book (CAAS single "O" type)

2.10.2 Local AMHS User address book for UA of all Implementations Under Test (IUT) ("XF" type).

Nick name	O/R Address ("XF" type)
IUTAFTNA	/C=XX/A=ICAO/P=IUTLAND-A/O=AFTN/OU1=IUTAFTNA/
IUTAFTNB	/C=XX/A=ICAO/P=IUTLAND-A/O=AFTN/OU1=IUTAFTNB/
IUTAFTNC	/C=XX/A=ICAO/P=IUTLAND-A/O=AFTN/OU1=IUTAFTNC/
till	**To be continued till**
IUTAFTNY	/C=XX/A=ICAO/P=IUTLAND-A/O=AFTN/OU1=IUTAFTNY/
IUTAFTAA	/C=XX/A=ICAO/P=IUTLAND-A/O=AFTN/OU1=IUTAFTAA/
till	**To be continued till**
IUTAFTAY	/C=XX/A=ICAO/P=IUTLAND-A/O=AFTN/OU1=IUTAFTAY/
IUTAFTUU	/C=XX/A=ICAO/P=IUTLAND-A/O=AFTN/OU1=IUTAFTUU/
IUTAMHSA	/C=XX/A=ICAO/P=IUTLAND-A/O=AFTN/OU1=IUTAMHSA/
IUTAMHSB	/C=XX/A=ICAO/P=IUTLAND-A/O=AFTN/OU1=IUTAMHSB/
IUTAMHSC	/C=XX/A=ICAO/P=IUTLAND-A/O=AFTN/OU1=IUTAMHSC/
IUTADLLO	/C=XX/A=ICAO/P=IUTLAND-A/O=AFTN/OU1=IUTADLLO/
IUTADLRE	/C=XX/A=ICAO/P=IUTLAND-A/O=AFTN/OU1=IUTADLRE/
IUTBFTNA	/C=XX/A=ICAO/P=IUTLAND-B/O=AFTN/OU1=IUTBFTNA/
IUTBFTNB	/C=XX/A=ICAO/P=IUTLAND-B/O=AFTN/OU1=IUTBFTNB/
IUTBFTNC	/C=XX/A=ICAO/P=IUTLAND-B/O=AFTN/OU1=IUTBFTNC/
till	**To be continued till**
IUTBFTNY	/C=XX/A=ICAO/P=IUTLAND-B/O=AFTN/OU1=IUTBFTNY/
IUTBFTAA	/C=XX/A=ICAO/P=IUTLAND-B/O=AFTN/OU1=IUTBFTAA/
till	**To be continued till**
IUTBFTAY	/C=XX/A=ICAO/P=IUTLAND-B/O=AFTN/OU1=IUTBFTAY/
IUTBFTUU	/C=XX/A=ICAO/P=IUTLAND-B/O=AFTN/OU1=IUTBFTUU/
IUTBMHSA	/C=XX/A=ICAO/P=IUTLAND-B/O=AFTN/OU1=IUTBMHSA/
IUTBMHSB	/C=XX/A=ICAO/P=IUTLAND-B/O=AFTN/OU1=IUTBMHSB/
IUTBMHSC	/C=XX/A=ICAO/P=IUTLAND-B/O=AFTN/OU1=IUTBMHSC/
IUTBDLLO	/C=XX/A=ICAO/P=IUTLAND-B/O=AFTN/OU1=IUTBDLLO/
IUTBDLRE	/C=XX/A=ICAO/P=IUTLAND-B/O=AFTN/OU1=IUTBDLRE/
IUTXLOOP	/C=XX/A=ICAO/P=IUTLAND-X/O=AFTN/OU1=IUTXLOOP/

Table 75: Local AMHS User address book ("XF" type)

2.11 **Bilateral Test Procedures**

2.11.1 Submission, Transfer and Delivery Operation (AMHS to AMHS)

2.11.1.1 IT101 – Submit, transfer and deliver an IPM (UA IUT-A to UA IUT-B)

IT101	**Submit, transfer and deliver an IPM (UA IUT-A to UA IUT-B)**
Test criteria	This test is successful, if the MTA of the sending IUT transfers the submitted ATS messages (IPM) correctly to a peer MTA which delivers the ATS messages (IPM) to the UA of the receiving IUT.
Scenario description	From the UA of IUT-A send a sequence of five ATS messages (IPMs) to the IUT addressing a remote AMHS user in the peer IUT, via AMHS. Message 1 (IT101M01) shall have ATS-message-priority KK. Message 2 (IT101M02) shall have ATS-message-priority GG. Message 3 (IT101M03) shall have ATS-message-priority FF. Message 4 (IT101M04) shall have ATS-message-priority DD. Message 5 (IT101M05) shall have ATS-message-priority SS. Each message shall have different ATS-filing-time and ATS-message-text. The *optional-heading-information* element shall be empty. Verify the messages received by the remote UA. In particular, verify: - ATS-message-priority, - ATS-message-filing-time, - ATS-message-text.
AMHS SARPs reference	Doc 9705-AN/956, 3.1.2.2.1 (ATS Message User Agent), 3.1.2.2.2 (ATS Message Server), 3.1.2.2.3.2.3 (ATS-Message-Header)
Related FIRST interoperability test(s)	ITP001/C41/C42
Test class	Normal AMHS communications (N)

2.11.1.2 IT102 – Submit, transfer and deliver an IPM (UA IUT-B to UA IUT-A)

IT102	**Submit, transfer and deliver an IPM (UA IUT-B to UA IUT-A)**
Test criteria	This test is successful, if the MTA of the sending IUT transfers the submitted ATS messages (IPM) correctly to a peer MTA which delivers the ATS messages (IPM) to the UA of the receiving IUT.
Scenario description	From the UA of IUT-B send a sequence of five ATS messages (IPMs) to the IUT addressing a remote AMHS user in the peer IUT, via AMHS. Message 1 (IT102M01) shall have ATS-message-priority KK. Message 2 (IT102M02) shall have ATS-message-priority GG. Message 3 (IT102M03) shall have ATS-message-priority FF. Message 4 (IT102M04) shall have ATS-message-priority DD. Message 5 (IT102M05) shall have ATS-message-priority SS.

IT102	Submit, transfer and deliver an IPM (UA IUT-B to UA IUT-A)
	Each message shall have different ATS-filing-time and ATS-message-text. The *optional-heading-information* element shall be empty. Verify the messages received by the remote UA. In particular, verify: - ATS-message-priority, - ATS-message-filing-time, - ATS-message-text.
AMHS SARPs reference	Doc 9705-AN/956, 3.1.2.2.1 (ATS Message User Agent), 3.1.2.2.2 (ATS Message Server), 3.1.2.2.3.2.3 (ATS-Message-Header)
Related FIRST interoperability test(s)	ITP001/C41/C42
Test class	Normal AMHS communications (N)

2.11.2 Gateway Operations (AFTN to AMHS)

2.11.2.1 IT201 – Convert an AFTN message to AMHS format (IUT-A)

IT201	Convert an AFTN message to AMHS format (IUT-A)
Test criteria	This test is successful, if the sending IUT converts AFTN messages correctly to AMHS messages (IPM).
Scenario description	From the sending IUT send a sequence of AFTN messages addressing a remote AMHS user, consisting of five messages: AFTN message 1 (IT201M01) shall have priority KK. AFTN message 2 (IT201M02) shall have priority GG. AFTN message 3 (IT201M03) shall have priority FF. AFTN message 4 (IT201M04) shall have priority DD. AFTN message 5 (IT201M05) shall have priority SS. The filing time shall be different in each message and the OHI field of each message shall be empty. Check the IPMs that the AMHS user receives in the receiving IUT. Verify that the IUT has converted the messages correctly according to Table 3.1.2-8 of the AMHS SARPs – see section 3.1.2.3.4.2. In particular: - verify that each message has different ATS-filing-time; - verify that the optional-heading-information element is empty; - check the correct format of the ATS message; - verify the ATS-message-priority and the related message transfer priority for each received message; - compare the ATS-message-text with the original AFTN message text.
AMHS SARPs reference	Doc 9705-AN/956, 3.1.2.3.4.2

IT201	Convert an AFTN message to AMHS format (IUT-A)
Related FIRST interoperability test(s)	ITP001/C21/C31/C51/C53
Test class	Normal AMHS communications (N)

2.11.2.2 IT202 – Convert an AFTN message to AMHS format (IUT-B)

IT202	Convert an AFTN message to AMHS format (IUT-B)
Test criteria	This test is successful, if the sending IUT converts AFTN messages correctly to AMHS messages (IPM).
Scenario description	From the sending IUT send a sequence of AFTN messages addressing a remote AMHS user, consisting of five messages: AFTN message 1 (IT202M01) shall have priority KK. AFTN message 2 (IT202M02) shall have priority GG. AFTN message 3 (IT202M03) shall have priority FF. AFTN message 4 (IT202M04) shall have priority DD. AFTN message 5 (IT202M05) shall have priority SS. The filing time shall be different in each message and the OHI field of each message shall be empty. Check the IPMs that the AMHS user receives in the receiving IUT. Verify that the IUT has converted the messages correctly according to Table 3.1.2-8 of the AMHS SARPs – see section 3.1.2.3.4.2. In particular: - verify that each message has different ATS-filing-time; - verify that the optional-heading-information element is empty; - check the correct format of the ATS message; - verify the ATS-message-priority and the related message transfer priority for each received message; - compare the ATS-message-text with the original AFTN message text.
AMHS SARPs reference	Doc 9705-AN/956, 3.1.2.3.4.2
Related FIRST interoperability test(s)	ITP001/C21/C31/C51/C53
Test class	Normal AMHS communications (N)

2.11.3 **Gateway Operations (AMHS to AFTN)**

2.11.3.1 IT301 – Convert an IPM generated by the UA of IUT-A to AFTN format

IT301	**Convert an IPM to AFTN format (IUT-B)**
Test criteria	This test is successful, if the receiving IUT converts IPMs correctly into AFTN format.
Scenario description	Send from IUT-A (UA) a sequence of ATS messages (IPMs) to the IUT-B, addressing an AFTN terminal. Message 1 (IT301M01) shall have ATS-message-priority KK. Message 2 (IT301M02) shall have ATS-message-priority GG. Message 3 (IT301M03) shall have ATS-message-priority FF. Message 4 (IT301M04) shall have ATS-message-priority DD. Message 5 (IT301M05) shall have ATS-message-priority SS. Each message shall have different ATS-filing-time and ATS-message-text. The *optional-heading-information* element shall be empty. The implicit-conversion-prohibited attribute of the AMHS message must be set to “false”. Check the correct format of the AFTN message. Verify the AFTN priority and filing time for each received message. Compare the AFTN message text with the original ATS-message-text.
AMHS SARPs reference	Doc 9705-AN/956, 3.1.2.3.5.2 (AMHS IPM conversion)
Related FIRST interoperability test(s)	ITP001/C31/C32/C52/C54
Test class	Normal AMHS communications (N)

2.11.3.2 IT302 – Convert an IPM generated by the UA of IUT-B to AFTN format

IT302	**Convert an IPM to AFTN format (IUT-A)**
Test criteria	This test is successful, if the receiving IUT converts IPMs correctly into AFTN format.
Scenario description	From the sending IUT send a sequence of ATS messages (IPMs) to the receiving IUT, addressing an AFTN terminal. Message 1 (IT302M01) shall have ATS-message-priority KK. Message 2 (IT302M02) shall have ATS-message-priority GG. Message 3 (IT302M03) shall have ATS-message-priority FF. Message 4 (IT302M04) shall have ATS-message-priority DD. Message 5 (IT302M05) shall have ATS-message-priority SS. Each message shall have different ATS-filing-time and ATS-message-text. The *optional-heading-information* element shall be empty. The implicit-conversion-prohibited attribute of the AMHS message must be set to “false”. Check the correct format of the AFTN message. Verify the AFTN priority and filing time for each received message. Compare the AFTN message text with the

IT302	Convert an IPM to AFTN format (IUT-A)
	original ATS-message-text.
AMHS SARPs reference	Doc 9705-AN/956, 3.1.2.3.5.2 (AMHS IPM conversion)
Related FIRST interoperability test(s)	ITP001/C31/C32/C52/C54
Test class	Normal AMHS communications (N)

2.11.4 Gateway Operations (AFTN to AMHS to AFTN)

2.11.4.1 IT401 – Convert an AFTN message to AMHS and back to AFTN format

IT401	Convert an AFTN message to AMHS and back to AFTN format
Test criteria	This test is successful, if the sending IUT-A converts AFTN user messages correctly to AMHS messages (IPM) and the IPMs are converted back to AFTN in IUT-B.
Scenario description	From IUT-A send a sequence of AFTN messages addressing a remote AFTN user in IUT-B, consisting of five messages: AFTN message 1 (IT401M01) shall have priority KK. AFTN message 2 (IT401M02) shall have priority GG. AFTN message 3 (IT401M03) shall have priority FF. AFTN message 4 (IT401M04) shall have priority DD. AFTN message 5 (IT401M05) shall have priority SS. The filing time shall be different in each message and the OHI field of each message shall be empty. Check the AFTN message received by the AFTN user in the IUT-B. Check the correct format of the AFTN message. Each AFTN message shall have original filing time. Each message shall have an empty OHI. Verify the AFTN priority for each received message. Compare the AFTN message text with the original AFTN message text.
AMHS SARPs reference	Doc 9705-AN/956, 3.1.2.3.4.2, 3.1.2.3.5.2
Related FIRST interoperability test(s)	ITP001/C21/C31/C51/C53
Test class	Normal AMHS communications (N)

2.11.4.2 IT402 – Convert an AFTN message to AMHS and back to AFTN format

IT402	Convert an AFTN message to AMHS and back to AFTN format
Test criteria	This test is successful, if the sending IUT-B converts AFTN user messages correctly to AMHS messages (IPM) and the IPMs are converted back to AFTN in IUT-A.
Scenario description	From IUT-B send a sequence of AFTN messages addressing a remote AFTN user in IUT-A, consisting of five messages: AFTN message 1 (IT402M01) shall have priority KK. AFTN message 2 (IT402M02) shall have priority GG. AFTN message 3 (IT402M03) shall have priority FF. AFTN message 4 (IT402M04) shall have priority DD. AFTN message 5 (IT402M05) shall have priority SS. The filing time shall be different in each message and the OHI field of each message shall be empty. Check the AFTN message received by the AFTN user in the IUT-A. Check the correct format of the AFTN message. Each AFTN message shall have original filing time. Each message shall have an empty OHI. Verify the AFTN priority for each received message. Compare the AFTN message text with the original AFTN message text.
AMHS SARPs reference	Doc 9705-AN/956, 3.1.2.3.4.2, 3.1.2.3.5.2
Related FIRST interoperability test(s)	ITP001/C21/C31/C51/C53
Test class	Normal AMHS communications (N)

2.11.5 Gateway Operations – special case scenarios

Note – The following special case scenarios are symmetric. That means, all test-cases have to be performed by IUT-A as well as IUT-B.

2.11.5.1 IT501 – Distribute an IPM to AMHS and AFTN users

IT501	Distribute an IPM to AMHS and AFTN users
Test criteria	This test is successful, if the receiving IUT distributes an IPM addressing both an AMHS and an AFTN user correctly.
Scenario description	From the sending IUT send an ATS message (IPM), addressing both AMHS and AFTN users, at the receiving IUT. The IPM Heading of the message shall contain two primary recipients, which are one AMHS and one AFTN user. The IPM Heading of the next message shall contain additionally, two copy recipients, which are also one AMHS and one AFTN user. Finally the IPM Heading of the last message shall contain additionally two blind

IT501	Distribute an IPM to AMHS and AFTN users
	copy recipients, which are also one AMHS and one AFTN user. Verify that all the users, whose addresses have been included in the IPM, receive the message correctly.
AMHS SARPs reference	Doc 9705-AN/956, 3.1.2.2.1 (ATS message user agent), 3.1.2.2.2 (ATS message server), 3.1.2.3.5.2 (IPM conversion)
Related FIRST interoperability test(s)	ITP053/C51/C52/C53/C54/C55/C56
Test class	Normal AMHS communications (N)

2.11.5.2 IT502 – Expand a DL addressing both AMHS and AFTN users

IT502	Expand a DL addressing both AMHS and AFTN users
Test criteria	This test is successful, if the receiving IUT distributes an IPM, addressing AMHS and AFTN users in a distribution list, correctly.
Scenario description	From the sending IUT send an ATS message (IPM) to the receiving IUT. The recipient contained in the MTE addresses a distribution list, for which the receiving IUT is responsible. The distribution list shall have the addresses of one AMHS user and two AFTN users as members. The message shall have the *dl-expansion-prohibited* attribute set to "false". Check the messages received in each AFTN user address verifying that each one contains its corresponding address.
AMHS SARPs reference	Doc 9705-AN/956, 3.1.2.2.2.1.1 (DL functional group), 3.1.2.3.5.2 (IPM conversion)
Related FIRST interoperability test(s)	ITP055/C51/C52, ITP057/C51/C52
Test class	Normal AMHS communications (N)

2.11.5.3 IT503 – Convert an IPM, if the ATS-message-text contains more than 1800 characters

IT503	Convert or reject an IPM, if the ATS-message-text contains more than 1800 characters
Test criteria	This test is successful, if the IUT, when it receives an ATS message with ATS-message-text longer than 1800 characters, rejects the message and returns a NDR, or splits the received IPM into several messages and converts the resulting messages into AFTN format as specified in ICAO Annex 10, Attm. , or converts the received IPM into a "long" AFTN message. *Note. – The AMHS SARPs (3.1.2.3.5.2.1.7) specify that the message can be rejected (case a) or split into several messages (case b).*

IT503	**Convert or reject an IPM, if the ATS-message-text contains more than 1800 characters**
Scenario description	From the sending IUT send an ATS message (IPM) containing ATS-message-text of 4500 characters to an AFTN recipient of the receiving IUT. *If case a is implemented:* Verify that the receiving IUT does not convert the IPM into AFTN format, but returns a NDR. Check the NDR contents received at the sending User Agent. Verify that the NDR contains the following elements: "unable-to-transfer" for the *non-delivery-reason-code*; "content-too-long" for the *non-delivery-diagnostic-code*; and "unable to convert to AFTN due to message text length" for the *supplementary-information*. *If case b is implemented:* Verify that (at least) three AFTN messages are received by the AFTN recipient. Check the correct format of the AFTN messages. Check the text field of all received AFTN messages. Verify that the text is complete and unchanged, i.e. compare the received data with the *ATS-message-text* provided in the original IPM. Verify that the received messages contain the sequence indicators as specified in Attm. B of ICAO Annex 10, Vol. II *If case c is implemented:* Verify that the AFTN message is received by the AFTN recipient. Check the correct format of the received AFTN message. Verify that the text is complete and unchanged, i.e. compare the received data with the *ATS-message-text* provided in the original IPM.
AMHS SARPs reference	Doc 9705-AN/956, 3.1.2.3.5.2.1.7
Related FIRST interoperability test(s)	ITP007/C31/C32/C51/C52
Test class	Normal AMHS communications (N)

2.11.5.4 IT504 – Split an incoming IPM addressing more than 21 AFTN users

IT504	**Split an incoming IPM addressing more than 21 AFTN users**
Test criteria	This test is successful, if the receiving IUT receives an ATS message (IPM) addressing more than 21 AFTN users and splits the received IPM into several messages each addressing 21 or less AFTN users. *Note. – PDR M4050004 (Title: AMHS - Too Many Recipients) is resolved. Therefore the message shall be split into several messages.*
Scenario description	From the sending IUT send an ATS message (IPM) to the receiving IUT. The message shall address 50 (primary) recipients. Verify that the receiving IUT converts the IPM into AFTN format and sends three AFTN messages to its AFTN component. Check the addressee indicators contained in the AFTN messages. Verify that no AFTN recipient is lost and the total number of AFTN addressee indicators contained in all three messages is 50. For example - the first AFTN message contains addressee indicators for the first 21 recipients, - the second AFTN message contains addressee indicators for the next 21 recipients, and

IT504	Split an incoming IPM addressing more than 21 AFTN users
	- the third AFTN message contains addressee indicators for the remaining 8 recipients.
AMHS SARPs reference	Doc 9705-AN/956, 3.1.2.3.5.2.1.8
Related FIRST interoperability test(s)	ITP008/C31/C32
Test class	Normal AMHS communications (N)

2.11.5.5 IT505 – Probe Conveyance Test

IT505	Probe Conveyance Test
Test criteria	This test is successful, if the receiving IUT generates a report (DR or NDR), when it receives a probe with AFTN users as intended recipients.
Scenario description	From the sending IUT, send AMHS probes to the receiving IUT: addressing two AFTN recipients and one AMHS recipient, addressing two AFTN recipients, one of which can be mapped and one of which cannot be mapped onto a valid AFTN address. Verify that the receiving IUT returns - one DR with 2 AFTN recipients from the MTCU and one DR with one recipient from the MTA - a combined DR and NDR or one DR and one NDR in response to the probe received. Verify in all cases that the DRs reporting about the AFTN addresses which could be translated contains the supplementary information “This report only indicates successful (potential) conversion to AFTN, not delivery to a recipient”.
AMHS SARPs reference	Doc 9705-AN/956, 3.1.2.3.5.5 (reception of AMHS probe), 3.1.2.3.5.6.2.27
Related FIRST interoperability test(s)	ITP066/C51/C52
Test class	Normal AMHS communications (N)

2.11.6 Stress traffic situations

2.11.6.1 IT601 – Stress load

IT601	**Stress load**
Test criteria	This test is successful, if both IUTs perform AMHS traffic interchange correctly for a number of messages queued in advance.
Scenario description	Defined numbers of messages (beginning with100, 200, till 400 messages) have to be selected from the data base or generated by the UA or the AFTN terminal. These messages need to be queued (in MTAs) in both IUTs, preferably by disabling the physical connector used to send information to the underlying network in one of the IUTs. When reconnecting, the messages queued in both IUTs will be sent simultaneously from the two sites, the rate being defined by the line speed of the interconnection, as well as the process followed by each system. No errors due to malfunction of the IUTs should be observed during the interchange period. The time from sending the first till receiving the last message has to be measured and analysed in both IUTs.
AMHS SARPs reference	None
Related FIRST interoperability test(s)	None
Test class	Normal (forced) AMHS communications (N)

2.12 Bilateral Test Procedures – Test Scenarios

2.12.1 Introduction

2.12.1.1 The following tables contain the scenarios for the different Interoperability Tests (IT) described in the previous chapters.

2.12.1.2 The test scenarios consist of several test-cases. The test-case reference is as follows:

ITxxx/TCzz

Test scenario: ITxxx where xxx is the scenario number

Test-case: TCzz where zz is the number of test-case.

2.12.1.3 *Personalization of the tests*: if two are the States that they carry out the tests, each one it will replace IUTA and IUTB for Site Indicator of Document 7910 that it corresponds them (e.g. if Paraguay - State A and Peru - State B executes the tests, IUTA will be replaced by SGAS and IUTB by SPIM).

2.12.2 Submission, Transfer and Delivery Operation (AMHS to AMHS)

IT101	**Submit, transfer and deliver an IPM (UA IUT-A to UA IUT-B)**		
Test-case id: **IT101/TC01**	Tested functionality: Submission, transfer and delivery of messages with different ATS-message-priorities A KK priority message will be submitted from the UA of IUT-A and delivered to the UA of IUT-B.		
Test description:	From the User Agent IUTAMHSA send the following message to the UA IUTBMHSA: PRI: KK FT: <FT> OHI: TEST IT101/TC01 Get the message with IUTBMHSA (UA-terminal of IUT-B).		
Test control:	Check the correct reception of the message at the UA IUTBMHSA of the IUT-B system. Check - the ATS-message-priority: PRI: KK - the ATS-message-filing-time and - the ATS-message-text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT101	**Submit, transfer and deliver an IPM (UA IUT-A to UA IUT-B)**		
Test-case id: **IT101/TC02**	Tested functionality: Submission, transfer and delivery of messages with different ATS-message-priorities A GG priority message will be submitted from the UA of IUT-A and delivered to the UA of IUT-B.		
Test description:	From the User Agent IUTAMHSA send the following message to the UA IUTBMHSA: PRI: GG FT: <FT> OHI: TEST IT101/TC02 Get the message with IUTBMHSA (UA-terminal of IUT-B).		
Test control:	Check the correct reception of the message at the UA IUTBMHSA of the IUT-B system. Check - the ATS-message-priority: PRI: GG - the ATS-message-filing-time and - the ATS-message-text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT101	**Submit, transfer and deliver an IPM (UA IUT-A to UA IUT-B)**		
Test-case id: **IT101/TC03**	Tested functionality: Submission, transfer and delivery of messages with different ATS-message-priorities An FF priority message will be submitted from the UA of IUT-A and delivered to the UA of IUT-B.		
Test description:	From the User Agent IUTAMHSA send the following message to the UA IUTBMHSA: PRI: FF FT: <FT> OHI: TEST IT101/TC03 Get the message with IUTBMHSA (UA-terminal of IUT-B).		
Test control:	Check the correct reception of the message at the UA IUTBMHSA of the IUT-B system. Check - the ATS-message-priority: PRI: FF - the ATS-message-filing-time and - the ATS-message-text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

<table>
<tr><th>IT101</th><th colspan="3">Submit, transfer and deliver an IPM (UA IUT-A to UA IUT-B)</th></tr>
<tr><td>Test-case id:
IT101/TC04</td><td colspan="3">Tested functionality: Submission, transfer and delivery of messages with different ATS-message-priorities
A DD priority message will be submitted from the UA of IUT-A and delivered to the UA of IUT-B.</td></tr>
<tr><td>Test description:</td><td colspan="3">From the User Agent IUTAMHSA send the following message to the UA IUTBMHSA:
PRI: DD
FT: <FT>
OHI:
TEST IT101/TC04
Get the message with IUTBMHSA (UA-terminal of IUT-B).</td></tr>
<tr><td>Test control:</td><td colspan="3">Check the correct reception of the message at the UA IUTBMHSA of the IUT-B system.
Check
- the ATS-message-priority: PRI: DD
- the ATS-message-filing-time and
- the ATS-message-text</td></tr>
<tr><td>Test result:</td><td>PASS</td><td>FAILED</td><td>INCONCLUSIVE</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>

<table>
<tr><th>IT101</th><th>Submit, transfer and deliver an IPM (UA IUT-A to UA IUT-B)</th></tr>
<tr><td>Test-case id:
IT101/TC05</td><td>Tested functionality: Submission, transfer and delivery of messages with different ATS-message-priorities
An SS priority message will be submitted from the UA of IUT-A and delivered to the UA of IUT-B.</td></tr>
<tr><td>Test description:</td><td>From the User Agent IUTAMHSA send the following message to the UA IUTBMHSA:
PRI: SS
FT: <FT>
OHI:
TEST IT101/TC05
Get the message with IUTBMHSA (UA-terminal of IUT-B). A RN is submitted when the message is displayed.
Note. – Depending on UA implementation the user might be requested to send the RN.</td></tr>
</table>

IT101	**Submit, transfer and deliver an IPM (UA IUT-A to UA IUT-B)**		
Test control:	Check the correct reception of the message at the UA IUTBMHSA of the IUT-B system. Check - the ATS-message-priority: PRI: SS - the ATS-message-filing-time and - the ATS-message-text Check the reception of a RN on the UA IUTAMHSA of the IUT-A system.		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT102	**Submit, transfer and deliver an IPM (UA IUT-B to UA IUT-A)**		
Test-case id: **IT102/TC01**	Tested functionality: Submission, transfer and delivery of messages with different ATS-message-priorities A KK priority message will be submitted from the UA of IUT-B and delivered to the UA of IUT-A.		
Test description:	From the User Agent IUTBMHSA send the following message to the UA IUTAMHSA: PRI: KK FT: <FT> OHI: TEST IT102/TC01 Get the message with IUTAMHSA (UA-terminal of IUT-A).		
Test control:	Check the correct reception of the message at the UA IUTAMHSA of the IUT-A system. Check - the ATS-message-priority: PRI: KK - the ATS-message-filing-time and - the ATS-message-text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT102	**Submit, transfer and deliver an IPM (UA IUT-B to UA IUT-A)**		
Test-case id: **IT102/TC02**	Tested functionality: Submission, transfer and delivery of messages with different ATS-message-priorities A GG priority message will be submitted from the UA of IUT-B and delivered to the UA of IUT-A.		
Test description:	From the User Agent IUTBMHSA send the following message to the UA IUTAMHSA: PRI: GG FT: <FT> OHI: TEST IT102/TC02 Get the message with IUTAMHSA (UA-terminal of IUT-A).		
Test control:	Check the correct reception of the message at the UA IUTAMHSA of the IUT-A system. Check - the ATS-message-priority: PRI: GG - the ATS-message-filing-time and - the ATS-message-text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT102	**Submit, transfer and deliver an IPM (UA IUT-B to UA IUT-A)**		
Test-case id: **IT102/TC03**	Tested functionality: Submission, transfer and delivery of messages with different ATS-message-priorities An FF priority message will be submitted from the UA of IUT-B and delivered to the UA of IUT-A.		
Test description:	From the User Agent IUTBMHSA send the following message to the UA IUTAMHSA: PRI: FF FT: <FT> OHI: TEST IT102/TC03 Get the message with IUTAMHSA (UA-terminal of IUT-A).		
Test control:	Check the correct reception of the message at the UA IUTAMHSA of the IUT-A system. Check - the ATS-message-priority: PRI: FF - the ATS-message-filing-time and - the ATS-message-text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT102	**Submit, transfer and deliver an IPM (UA IUT-B to UA IUT-A)**		
Test-case id: **IT102/TC04**	Tested functionality: Submission, transfer and delivery of messages with different ATS-message-priorities A DD priority message will be submitted from the UA of IUT-B and delivered to the UA of IUT-A.		
Test description:	From the User Agent IUTBMHSA send the following message to the UA IUTAMHSA: PRI: DD FT: <FT> OHI: TEST IT102/TC04 Get the message with IUTAMHSA (UA-terminal of IUT-A)		
Test control:	Check the correct reception of the message at the UA IUTAMHSA of the IUT-A system. Check - the ATS-message-priority: PRI: DD - the ATS-message-filing-time and - the ATS-message-text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT102	**Submit, transfer and deliver an IPM (UA IUT-B to UA IUT-A)**
Test-case id: **IT102/TC05**	Tested functionality: Submission, transfer and delivery of messages with different ATS-message-priorities An SS priority message will be submitted from the UA of IUT-B and delivered to the UA of IUT-A.
Test description:	From the User Agent IUTBMHSA send the following message to the UA IUTAMHSA: PRI: SS FT: <FT> OHI: TEST IT102/TC05 Get the message with IUTAMHSA (UA-terminal of IUT-A). A RN is submitted when the message is displayed. *Note. – Depending on UA implementation the user might be requested to send the RN.*

IT102	Submit, transfer and deliver an IPM (UA IUT-B to UA IUT-A)		
Test control:	Check the correct reception of the message at the UA IUTAMHSA of the IUT-A system. Check - the ATS-message-priority: PRI: SS - the ATS-message-filing-time and - the ATS-message-text Check the reception of a RN on the UA IUTBMHSA of the IUT-B system.		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

2.12.3 Gateway Operations (AFTN to AMHS)

IT201	Convert an AFTN message to AMHS format (IUT-A)		
Test-case id: **IT201/TC01**	Tested functionality: Conversion of messages with different AFTN priorities A KK priority message will be sent from the AFTN terminal of IUT-A, converted to AMHS and received at the UA of IUT-B.		
Test description:	From the AFTN terminal IUTAFTNA of IUT-A send the following message to the User Agent (UA) of IUT-B: KK IUTBMHSA <FT> IUTAFTNA TEST IT201/TC01 The message is converted from AFTN into AMHS format in the MTCU of IUT-A.		
Test control:	Check the correct reception of the message at the UA IUTBMHSA of the IUT-B system. Check - the ATS-message-priority: PRI: KK - the message transfer priority: NON URGENT - the ATS-message-filing-time and - the ATS-message-text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT201	Convert an AFTN message to AMHS format (IUT-A)		
Test-case id: **IT201/TC02**	Tested functionality: Conversion of messages with different AFTN priorities A GG priority message will be sent from the AFTN terminal of IUT-A, converted to AMHS and received at the UA of IUT-B.		
Test description:	From the AFTN terminal IUTAFTNA of IUT-A send the following message to the User Agent (UA) of IUT-B: GG IUTBMHSA <FT> IUTAFTNA TEST IT201/TC02 The message is converted from AFTN into AMHS format in the MTCU of IUT-A.		
Test control:	Check the correct reception of the message at the UA IUTBMHSA of the IUT-B system. Check - the ATS-message-priority: PRI: GG - the message transfer priority: NON URGENT - the ATS-message-filing-time and - the ATS-message-text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT201	Convert an AFTN message to AMHS format (IUT-A)		
Test-case id: **IT201/TC03**	Tested functionality: Conversion of messages with different AFTN priorities An FF priority message will be sent from the AFTN terminal of IUT-A, converted to AMHS and received at the UA of IUT-B.		
Test description:	From the AFTN terminal IUTAFTNA of IUT-A send the following message to the User Agent (UA) of IUT-B: FF IUTBMHSA <FT> IUTAFTNA TEST IT201/TC03 The message is converted from AFTN into AMHS format in the MTCU of IUT-A.		
Test control:	Check the correct reception of the message at the UA IUTBMHSA of the IUT-B system. Check - the ATS-message-priority: PRI: FF - the message transfer priority: NORMAL - the ATS-message-filing-time and - the ATS-message-text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT201	**Convert an AFTN message to AMHS format (IUT-A)**		
Test-case id: **IT201/TC04**	Tested functionality: Conversion of messages with different AFTN priorities A DD priority message will be sent from the AFTN terminal of IUT-A, converted to AMHS and received at the UA of IUT-B.		
Test description:	From the AFTN terminal IUTAFTNA of IUT-A send the following message to the User Agent (UA) of IUT-B: DD IUTBMHSA <FT> IUTAFTNA TEST IT201/TC04 The message is converted from AFTN into AMHS format in the MTCU of IUT-A.		
Test control:	Check the correct reception of the message at the UA IUTBMHSA of the IUT-B system. Check - the ATS-message-priority: PRI: DD - the message transfer priority: NORMAL - the ATS-message-filing-time and - the ATS-message-text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT201	**Convert an AFTN message to AMHS format (IUT-A)**
Test-case id: **IT201/TC05**	Tested functionality: Conversion of messages with different AFTN priorities An SS priority message will be sent from the AFTN terminal of IUT-A, converted to AMHS and received at the UA of IUT-B.
Test description:	From the AFTN terminal IUTAFTNA of IUT-A send the following message to the User Agent (UA) of IUT-B: SS IUTBMHSA <FT> IUTAFTNA TEST IT201/TC05 The message is converted from AFTN into AMHS format in the MTCU of IUT-A. *Optional:* *Generate a RN at the receiving UA IUTBMHSA of ITU-B.*

IT201	**Convert an AFTN message to AMHS format (IUT-A)**		
Test control:	Check the correct reception of the message at the UA IUTBMHSA of the IUT-B system. Check - the ATS-message-priority: PRI: SS - the message transfer priority: URGENT - the ATS-message-filing-time and - the ATS-message-text *Optional:* *If a RN is replied from the UA IUTBMHSA of ITU-B, the MTCU of IUT-A converts it into an SS Ack message which is sent to the AFTN terminal of IUT-A.* *Check the reception of the SS Ack message at the AFTN terminal IUTAFTNA of IUT-A. .Its originator indicator shall be the AFTN address IUTBMHSA, and its text shall be "R <FT> IUTAFTNA", where <FT> denotes the filing time of the subject AFTN message.*		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT202	**Convert an AFTN message to AMHS format (IUT-B)**		
Test-case id: **IT202/TC01**	Tested functionality: Conversion of messages with different AFTN priorities A KK priority message will be sent from the AFTN terminal of IUT-B, converted to AMHS and received at the UA of IUT-A.		
Test description:	From the AFTN terminal IUTBFTNA of IUT-B send the following message to the User Agent (UA) of IUT-A: KK IUTAMHSA <FT> IUTBFTNA TEST IT202/TC01 The message is converted from AFTN into AMHS format in the MTCU of IUT-B.		
Test control:	Check the correct reception of the message at the UA IUTAMHSA of the IUT-A system. Check - the ATS-message-priority: PRI: KK - the message transfer priority: NON URGENT - the ATS-message-filing-time and - the ATS-message-text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT202	**Convert an AFTN message to AMHS format (IUT-B)**		
Test-case id: **IT202/TC02**	Tested functionality: Conversion of messages with different AFTN priorities A GG priority message will be sent from the AFTN terminal of IUT-B, converted to AMHS and received at the UA of IUT-A.		
Test description:	From the AFTN terminal IUTBFTNA of IUT-B send the following message to the User Agent (UA) of IUT-A: GG IUTAMHSA <FT> IUTBFTNA TEST IT202/TC02 The message is converted from AFTN into AMHS format in the MTCU of IUT-B.		
Test control:	Check the correct reception of the message at the UA IUTAMHSA of the IUT-A system. Check - the ATS-message-priority: PRI: GG - the message transfer priority: NON URGENT - the ATS-message-filing-time and - the ATS-message-text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT202	**Convert an AFTN message to AMHS format (IUT-B)**		
Test-case id: **IT202/TC03**	Tested functionality: Conversion of messages with different AFTN priorities An FF priority message will be sent from the AFTN terminal of IUT-B, converted to AMHS and received at the UA of IUT-A.		
Test description:	From the AFTN terminal IUTBFTNA of IUT-B send the following message to the User Agent (UA) of IUT-A: FF IUTAMHSA <FT> IUTBFTNA TEST IT202/TC03 The message is converted from AFTN into AMHS format in the MTCU of IUT-B.		
Test control:	Check the correct reception of the message at the UA IUTAMHSA of the IUT-A system. Check - the ATS-message-priority: PRI: FF - the message transfer priority: NORMAL - the ATS-message-filing-time and - the ATS-message-text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

<table>
<tr><th>IT202</th><th colspan="3">Convert an AFTN message to AMHS format (IUT-B)</th></tr>
<tr><td>Test-case id:
IT202/TC04</td><td colspan="3">Tested functionality: Conversion of messages with different AFTN priorities
A DD priority message will be sent from the AFTN terminal of IUT-B, converted to AMHS and received at the UA of IUT-A.</td></tr>
<tr><td>Test description:</td><td colspan="3">From the AFTN terminal IUTBFTNA of IUT-B send the following message to the User Agent (UA) of IUT-A:
DD IUTAMHSA
<FT> IUTBFTNA
TEST IT202/TC04
The message is converted from AFTN into AMHS format in the MTCU of IUT-B.</td></tr>
<tr><td>Test control:</td><td colspan="3">Check the correct reception of the message at the UA IUTAMHSA of the IUT-A system.
Check
- the ATS-message-priority: PRI: DD
- the message transfer priority: NORMAL
- the ATS-message-filing-time and
- the ATS-message-text</td></tr>
<tr><td>Test result:</td><td>PASS</td><td>FAILED</td><td>INCONCLUSIVE</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>

IT202	Convert an AFTN message to AMHS format (IUT-B)
Test-case id: **IT202/TC05**	Tested functionality: Conversion of messages with different AFTN priorities An SS priority message will be sent from the AFTN terminal of IUT-B, converted to AMHS and received at the UA of IUT-A.
Test description:	From the AFTN terminal IUTBFTNA of IUT-B send the following message to the User Agent (UA) of IUT-A: SS IUTAMHSA <FT> IUTBFTNA TEST IT202/TC05 The message is converted from AFTN into AMHS format in the MTCU of IUT-B. *Optional:* *Generate a RN at the receiving UA IUTAMHSA of ITU-A.*

IT202	Convert an AFTN message to AMHS format (IUT-B)		
Test control:	Check the correct reception of the message at the UA IUTAMHSA of the IUT-A system. Check - the ATS-message-priority: PRI: SS - the message transfer priority: URGENT - the ATS-message-filing-time and - the ATS-message-text *Optional:* *If a RN is replied from the UA IUTAMHSA of ITU-A, the MTCU of IUT-B converts it into an SS Ack message which is sent to the AFTN terminal of IUT-B.* *Check the reception of the SS Ack message at the AFTN terminal IUTBFTNA of IUT-B. Its originator indicator shall be the AFTN address IUTAMHSA, and its text shall be “R <FT> IUTBFTNA”, where <FT> denotes the filing time of the subject AFTN message.*		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

2.12.4 Gateway Operations (AMHS to AFTN)

IT301	Convert an IPM to AFTN format (IUT-B)		
Test-case id: **IT301/TC01**	Tested functionality: Conversion of messages with different ATS-message-priorities A KK priority message will be submitted from the UA of IUT-A, converted to AFTN in IUT-B and received at the AFTN terminal of IUT-B.		
Test description:	From the User Agent IUTAMHSA send the following message to the AFTN terminal IUTBFTNA of IUT-B: PRI: KK FT: <FT> OHI: TEST IT301/TC01 The message is converted from AMHS into AFTN format in the MTCU of IUT-B.		
Test control:	Check the correct reception of the message at the AFTN terminal IUTBFTNA of the IUT-B system. Check - the AFTN priority: KK - the AFTN filing time and - the AFTN message text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT301	Convert an IPM to AFTN format (IUT-B)		
Test-case id: **IT301/TC02**	Tested functionality: Conversion of messages with different ATS-message-priorities A GG priority message will be submitted from the UA of IUT-A, converted to AFTN in IUT-B and received at the AFTN terminal of IUT-B.		
Test description:	From the User Agent IUTAMHSA send the following message to the AFTN terminal IUTBFTNA of IUT-B: PRI: GG FT: <FT> OHI: TEST IT301/TC02 The message is converted from AMHS into AFTN format in the MTCU of IUT-B.		
Test control:	Check the correct reception of the message at the AFTN terminal IUTBFTNA of the IUT-B system. Check - the AFTN priority: GG - the AFTN filing time and - the AFTN message text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT301	Convert an IPM to AFTN format (IUT-B)
Test-case id: **IT301/TC03**	Tested functionality: Conversion of messages with different ATS-message-priorities An FF priority message will be submitted from the UA of IUT-A, converted to AFTN in IUT-B and received at the AFTN terminal of IUT-B.
Test description:	From the User Agent IUTAMHSA send the following message to the AFTN terminal IUTBFTNA of IUT-B: PRI: FF FT: <FT> OHI: TEST IT301/TC03 The message is converted from AMHS into AFTN format in the MTCU of IUT-B.

IT301	**Convert an IPM to AFTN format (IUT-B)**		
Test control:	Check the correct reception of the message on the AFTN terminal IUTBFTNA of the IUT-B system. Check - the AFTN priority: FF - the AFTN filing time and - the AFTN message text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT301	**Convert an IPM to AFTN format (IUT-B)**		
Test-case id: **IT301/TC04**	Tested functionality: Conversion of messages with different ATS-message-priorities A DD priority message will be submitted from the UA of IUT-A, converted to AFTN in IUT-B and received at the AFTN terminal of IUT-B.		
Test description:	From the User Agent IUTAMHSA send the following message to the AFTN terminal IUTBFTNA of IUT-B: PRI: DD FT: <FT> OHI: TEST IT301/TC04 The message is converted from AMHS into AFTN format in the MTCU of IUT-B.		
Test control:	Check the correct reception of the message on the AFTN terminal IUTBFTNA of the IUT-B system. Check - the AFTN priority: DD - the AFTN filing time and - the AFTN message text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT301	**Convert an IPM to AFTN format (IUT-B)**		
Test-case id: **IT301/TC05**	Tested functionality: Conversion of messages with different ATS-message-priorities An SS priority message will be submitted from the UA of IUT-A, converted to AFTN in IUT-B and received at the AFTN terminal of IUT-B		
Test description:	From the User Agent IUTAMHSA send the following message to the AFTN terminal IUTBFTNA of IUT-B: PRI: SS FT: <FT> OHI: TEST IT301/TC05 The message is converted from AMHS into AFTN format in the MTCU of IUT-B. *Optional:* *Send an SS Acknowledgement message from the receiving AFTN terminal.*		
Test control:	Check the correct reception of the message on the AFTN terminal IUTBFTNA of the IUT-B system. Check - the AFTN priority: SS - the AFTN filing time and - the AFTN message text - *Optional:* *When the SS Ack message is replied, the MTCU of IUT-B converts it into a RN.* *Check the reception of the RN at the UA IUTAMHSA of ITU-A.*		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT302	**Convert an IPM to AFTN format (IUT-A)**
Test-case id: **IT302/TC01**	Tested functionality: Conversion of messages with different ATS-message-priorities A KK priority message will be submitted from the UA of IUT-B, converted to AFTN in IUT-A and received at the AFTN terminal of IUT-A.
Test description:	From the User Agent IUTBMHSA send the following message to the AFTN terminal IUTAFTNA of IUT-A: PRI: KK FT: <FT> OHI: TEST IT302/TC01 The message is converted from AMHS into AFTN format in the MTCU of IUT-A.

<table>
<tr><th>IT302</th><th colspan="3">Convert an IPM to AFTN format (IUT-A)</th></tr>
<tr><td>Test control:</td><td colspan="3">Check the correct reception of the message on the AFTN terminal IUTAFTNA of the IUT-A system.
Check
- the AFTN priority: KK
- the AFTN filing time and
- the AFTN message text</td></tr>
<tr><td>Test result:</td><td>PASS</td><td>FAILED</td><td>INCONCLUSIVE</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>

<table>
<tr><th>IT302</th><th colspan="3">Convert an IPM to AFTN format (IUT-A)</th></tr>
<tr><td>Test-case id:
IT302/TC02</td><td colspan="3">Tested functionality: Conversion of messages with different ATS-message-priorities
A GG priority message will be submitted from the UA of IUT-B, converted to AFTN in IUT-A and received at the AFTN terminal of IUT-A.</td></tr>
<tr><td>Test description:</td><td colspan="3">From the User Agent IUTBMHSA send the following message to the AFTN terminal IUTAFTNA of IUT-A:
PRI: GG
FT: <FT>
OHI:
TEST IT302/TC02
The message is converted from AMHS into AFTN format in the MTCU of IUT-A.</td></tr>
<tr><td>Test control:</td><td colspan="3">Check the correct reception of the message on the AFTN terminal IUTAFTNA of the IUT-A system.
Check
- the AFTN priority: GG
- the AFTN filing time and
- the AFTN message text</td></tr>
<tr><td>Test result:</td><td>PASS</td><td>FAILED</td><td>INCONCLUSIVE</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>

IT302	**Convert an IPM to AFTN format (IUT-A)**		
Test-case id: **IT302/TC03**	Tested functionality: Conversion of messages with different ATS-message-priorities An FF priority message will be submitted from the UA of IUT-B, converted to AFTN in IUT-A and received at the AFTN terminal of IUT-A.		
Test description:	From the User Agent IUTBMHSA send the following message to the AFTN terminal IUTAFTNA of IUT-A: PRI: FF FT: <FT> OHI: TEST IT302/TC03 The message is converted from AMHS into AFTN format in the MTCU of IUT-A.		
Test control:	Check the correct reception of the message on the AFTN terminal IUTAFTNA of the IUT-A system. Check - the AFTN priority: FF - the AFTN filing time and - the AFTN message text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT302	**Convert an IPM to AFTN format (IUT-A)**
Test-case id: **IT302/TC04**	Tested functionality: Conversion of messages with different ATS-message-priorities A DD priority message will be submitted from the UA of IUT-B, converted to AFTN in IUT-A and received at the AFTN terminal of IUT-A.
Test description:	From the User Agent IUTBMHSA send the following message to the AFTN terminal IUTAFTNA of IUT-A: PRI: DD FT: <FT> OHI: TEST IT302/TC04 The message is converted from AMHS into AFTN format in the MTCU of IUT-A.

IT302	Convert an IPM to AFTN format (IUT-A)		
Test control:	Check the correct reception of the message on the AFTN terminal IUTAFTNA of the IUT-A system. Check - the AFTN priority: DD - the AFTN filing time and - the AFTN message text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT302	Convert an IPM to AFTN format (IUT-A)		
Test-case id: **IT302/TC05**	Tested functionality: Conversion of messages with different ATS-message-priorities An SS priority message will be submitted from the UA of IUT-B, converted to AFTN in IUT-A and received at the AFTN terminal of IUT-A.		
Test description:	From the User Agent IUTBMHSA send the following message to the AFTN terminal IUTAFTNA of IUT-A: PRI: SS FT: <FT> OHI: TEST IT302/TC05 The message is converted from AMHS into AFTN format in the MTCU of IUT-A. *Optional:* *Send an SS Acknowledgement message from the receiving AFTN terminal.*		
Test control:	Check the correct reception of the message on the AFTN terminal IUTAFTNA of the IUT-A system. Check - the AFTN priority: SS - the AFTN filing time and - the AFTN message text - *Optional:* *When the SS Ack message is replied, the MTCU of IUT-A converts it into a RN.* *Check the reception of the RN at the UA IUTBMHSA of ITU-B.*		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

2.12.5 Gateway Operations (AFTN to AMHS to AFTN)

IT401	**Convert an AFTN message to an IPM and back to AFTN format (IUT-A to IUT-B)**		
Test-case id: **IT401/TC01**	Tested functionality: Conversion of messages with different AFTN priorities An AFTN message with KK priority will be sent from the AFTN terminal of IUT-A to the AFTN terminal of IUT-B.		
Test description:	From the AFTN terminal IUTAFTNA send the following message to the AFTN terminal IUTBFTNA of IUT-B: KK IUTBFTNA <FT> IUTAFTNA TEST IT401/TC01 The message is - converted from AFTN into AMHS format in the MTCU of IUT-A, - transferred via the MTA o IUT A to the MTA of IUT-B, -routed to the MTCU of IUT-B and - converted from AMHS into AFTN format in the MTCU of IUT-B.		
Test control:	Check the correct reception of the message on the AFTN terminal IUTBFTNA of the IUT-B system. Check the AFTN priority: KK the AFTN filing time and the AFTN message text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT401	**Convert an AFTN message to an IPM and back to AFTN format (IUT-A to IUT-B)**
Test-case id: **IT401/TC02**	Tested functionality: Conversion of messages with different AFTN priorities An AFTN message with GG priority will be sent from the AFTN terminal of IUT-A to the AFTN terminal of IUT-B.
Test description:	From the AFTN terminal IUTAFTNA send the following message to the AFTN terminal IUTBFTNA of IUT-B: GG IUTBFTNA <FT> IUTAFTNA TEST IT401/TC02 The message is - converted from AFTN into AMHS format in the MTCU of IUT-A, - transferred via the MTA of IUT A to the MTA of IUT-B, - routed to the MTCU of IUT-B and - converted from AMHS into AFTN format in the MTCU of IUT-B.

IT401	**Convert an AFTN message to an IPM and back to AFTN format (IUT-A to IUT-B)**		
Test control:	Check the correct reception of the message on the AFTN terminal IUTBFTNA of the IUT-B system. Check - the AFTN priority: GG - the AFTN filing time and - the AFTN message text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT401	**Convert an AFTN message to an IPM and back to AFTN format (IUT-A to IUT-B)**		
Test-case id: **IT401/TC03**	Tested functionality: Conversion of messages with different AFTN priorities An AFTN message with FF priority will be sent from the AFTN terminal of IUT-A to the AFTN terminal of IUT-B.		
Test description:	From the AFTN terminal IUTAFTNA send the following message to the AFTN terminal IUTBFTNA of IUT-B: FF IUTBFTNA <FT> IUTAFTNA TEST IT401/TC03 The message is - converted from AFTN into AMHS format in the MTCU of IUT-A, - transferred via the MTA of IUT A to the MTA of IUT-B, - routed to the MTCU of IUT-B and - converted from AMHS into AFTN format in the MTCU of IUT-B.		
Test control:	Check the correct reception of the message on the AFTN terminal IUTBFTNA of the IUT-B system. Check - the AFTN priority: FF - the AFTN filing time and - the AFTN message text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT401	**Convert an AFTN message to an IPM and back to AFTN format (IUT-A to IUT-B)**		
Test-case id: **IT401/TC04**	Tested functionality: Conversion of messages with different AFTN priorities An AFTN message with DD priority will be sent from the AFTN terminal of IUT-A to the AFTN terminal of IUT-B.		
Test description:	From the AFTN terminal IUTAFTNA send the following message to the AFTN terminal IUTBFTNA of IUT-B: DD IUTBFTNA <FT> IUTAFTNA TEST IT401/TC04 The message is - converted from AFTN into AMHS format in the MTCU of IUT-A, - transferred via the MTA of IUT A to the MTA of IUT-B, - routed to the MTCU of IUT-B and - converted from AMHS into AFTN format in the MTCU of IUT-B.		
Test control:	Check the correct reception of the message on the AFTN terminal IUTBFTNA of the IUT-B system. Check - the AFTN priority: DD - the AFTN filing time and - the AFTN message text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT401	**Convert an AFTN message to an IPM and back to AFTN format (IUT-A to IUT-B)**
Test-case id: **IT401/TC05**	Tested functionality: Conversion of messages with different AFTN priorities An AFTN message with SS priority will be sent from the AFTN terminal of IUT-A to the AFTN terminal of IUT-B.
Test description:	From the AFTN terminal IUTAFTNA send the following message to the AFTN terminal IUTBFTNA of IUT-B: SS IUTBFTNA <FT> IUTAFTNA TEST IT401/TC05 The message is - converted from AFTN into AMHS format in the MTCU of IUT-A, - transferred via the MTA of IUT A to the MTA of IUT-B, - routed to the MTCU of IUT-B and - converted from AMHS into AFTN format in the MTCU of IUT-B. *Optional:* *Send an SS Acknowledgement message from the receiving AFTN terminal.*

IT401	**Convert an AFTN message to an IPM and back to AFTN format (IUT-A to IUT-B)**		
Test control:	Check the correct reception of the message on the AFTN terminal IUTBFTNA of the IUT-B system. Check - the AFTN priority: SS - the AFTN filing time and - the AFTN message text *Optional:* *When the SS Ack message is replied, the MTCU of IUT-B converts it into a RN, the RN is re-converted to an SS Acknowledgement message in the MTCU of IUT-A.* *Check the reception of the SS Acknowledgement at the AFTN terminal IUTAFTNA of ITU-A.*		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT402	**Convert an AFTN message to an IPM and back to AFTN format (IUT-B to IUT-A)**		
Test-case id: **IT402/TC01**	Tested functionality: Conversion of messages with different AFTN priorities An AFTN message with KK priority will be sent from the AFTN terminal of IUT-B to the AFTN terminal of IUT-A.		
Test description:	From the AFTN terminal IUTBFTNA send the following message to the AFTN terminal IUTAFTNA of IUT-A: KK IUTAFTNA <FT> IUTBFTNA TEST IT402/TC01 The message is - converted from AFTN into AMHS format in the MTCU of IUT-B, - transferred via the MTA of IUT B to the MTA of IUT-A, - routed to the MTCU of IUT-A and - converted from AMHS into AFTN format in the MTCU of IUT-A.		
Test control:	Check the correct reception of the message on the AFTN terminal IUTAFTNA of the IUT-A system. Check - the AFTN priority: KK - the AFTN filing time and - the AFTN message text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

<table>
<tr><th>IT402</th><th colspan="3">Convert an AFTN message to an IPM and back to AFTN format (IUT-B to IUT-A)</th></tr>
<tr><td>Test-case id:
IT402/TC02</td><td colspan="3">Tested functionality: Conversion of messages with different AFTN priorities
An AFTN message with GG priority will be sent from IUT-B to the AFTN terminal of IUT-A.</td></tr>
<tr><td>Test description:</td><td colspan="3">From the AFTN terminal IUTBFTNA send the following message to the AFTN terminal IUTAFTNA of IUT-A:
GG IUTAFTNA
<FT> IUTBFTNA
TEST IT402/TC02
The message is
- converted from AFTN into AMHS format in the MTCU of IUT-B,
- transferred via the MTA of IUT B to the MTA of IUT-A,
- routed to the MTCU of IUT-A and
- converted from AMHS into AFTN format in the MTCU of IUT-A.</td></tr>
<tr><td>Test control:</td><td colspan="3">Check the correct reception of the message on the AFTN terminal IUTAFTNA of the IUT-A system.
Check
- the AFTN priority: GG
- the AFTN filing time and
- the AFTN message text</td></tr>
<tr><td>Test result:</td><td>PASS</td><td>FAILED</td><td>INCONCLUSIVE</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>

<table>
<tr><th>IT402</th><th>Convert an AFTN message to an IPM and back to AFTN format (IUT-B to IUT-A)</th></tr>
<tr><td>Test-case id:
IT402/TC03</td><td>Tested functionality: Conversion of messages with different AFTN priorities
An AFTN message with FF priority will be sent from the AFTN terminal of IUT-B to the AFTN terminal of IUT-A.</td></tr>
<tr><td>Test description:</td><td>From the AFTN terminal IUTBFTNA send the following message to the AFTN terminal IUTAFTNA of IUT-A:
FF IUTAFTNA
<FT> IUTBFTNA
TEST IT402/TC03
The message is
- converted from AFTN into AMHS format in the MTCU of IUT-B,
- transferred via the MTA of IUT B to the MTA of IUT-A,
- routed to the MTCU of IUT-A and
- converted from AMHS into AFTN format in the MTCU of IUT-A.</td></tr>
</table>

IT402	**Convert an AFTN message to an IPM and back to AFTN format (IUT-B to IUT-A)**		
Test control:	Check the correct reception of the message on the AFTN terminal IUTAFTNA of the IUT-A system. Check - the AFTN priority: FF - the AFTN filing time and - the AFTN message text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT402	**Convert an AFTN message to an IPM and back to AFTN format (IUT-B to IUT-A)**		
Test-case id: **IT402/TC04**	Tested functionality: Conversion of messages with different AFTN priorities An AFTN message with DD priority will be sent from the AFTN terminal of IUT-B to the AFTN terminal of IUT-A.		
Test description:	From the AFTN terminal IUTBFTNA send the following message to the AFTN terminal IUTAFTNA of IUT-A: DD IUTAFTNA <FT> IUTBFTNA TEST IT402/TC04 The message is - converted from AFTN into AMHS format in the MTCU of IUT-B, - transferred via the MTA of IUT B to the MTA of IUT-A, - routed to the MTCU of IUT-A and - converted from AMHS into AFTN format in the MTCU of IUT-A.		
Test control:	Check the correct reception of the message on the AFTN terminal IUTAFTNA of the IUT-A system. Check - the AFTN priority: DD - the AFTN filing time and - the AFTN message text		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT402	**Convert an AFTN message to an IPM and back to AFTN format (IUT-B to IUT-A)**		
Test-case id: **IT402/TC05**	Tested functionality: Conversion of messages with different AFTN priorities An AFTN message with SS priority will be sent from the AFTN terminal of IUT-B to the AFTN terminal of IUT-A.		
Test description:	From the AFTN terminal of IUTBFTNA send the following message to the AFTN terminal IUTAFTNA of IUT-A: SS IUTAFTNA <FT> IUTBFTNA TEST IT402/TC05 The message is - converted from AFTN into AMHS format in the MTCU of IUT-B, - transferred via the MTA of IUT B to the MTA of IUT-A, - routed to the MTCU of IUT-A and - converted from AMHS into AFTN format in the MTCU of IUT-A. *Optional:* *Send an SS Acknowledgement message from the receiving AFTN terminal.*		
Test control:	Check the correct reception of the message on the AFTN terminal IUTAFTNA of the IUT-A system. Check - the AFTN priority: SS - the AFTN filing time and - the AFTN message text *Optional:* *When the SS Ack message is replied, the MTCU of IUT-A converts it into a RN, the RN is re-converted to an SS Acknowledgement message in the MTCU of IUT-B.* *Check the reception of the SS Acknowledgement at the AFTN terminal IUTBFTNA of ITU-B.*		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

2.12.6 **Gateway Operations – special cases**

IT501	**Distribute an IPM to AMHS and AFTN users**		
Test-case id: **IT501/TC01**	Tested functionality: Distribution of IPM A message will be sent from a UA on IUT-A to IUT-B with Primary Recipients addressing an AFTN terminal and a UA in IUT-B.		
Test description:	From IUTAMHSA send the following message to: Primary Recipients: IUTBMHSA and IUTBFTNA PRI: FF FT: <FT> TEST IT501/TC01 Get the message at the UA- and AFTN terminals of SUT-B.		
Test control:	Check the correct reception of the message by IUTBFTNA and IUTBMHSA in the IUT-B configuration.		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT501	**Distribute an IPM to AMHS and AFTN users**		
Test-case id: **IT501/TC02**	Tested functionality: Distribution of IPM A message will be sent from a UA on IUT-B to IUT-A with Primary Recipients addressing an AFTN terminal and a UA in IUT-A.		
Test description:	From IUTBMHSA send the following message to: Primary Recipients: IUTAMHSA and IUTAFTNA PRI: FF FT: <FT> TEST IT501/TC02 Get the message at the UA- and AFTN terminals of SUT-A.		
Test control:	Check the correct reception of the message by IUTAFTNA and IUTAMHSA in the IUT-A configuration.		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT501	**Distribute an IPM to AMHS and AFTN users**		
Test-case id: **IT501/TC03**	Tested functionality: Distribution of IPM A message will be sent from a UA on IUT-A to IUT-B with Primary Recipients and Copy Recipients, addressing AFTN terminals and UAs in IUT-B.		
Test description:	From IUTAMHSA send the following message to: Primary Recipients: IUTBMHSA and IUTBFTNA Copy Recipients: IUTBMHSB and IUTBFTNB PRI: FF FT: <FT> TEST IT501/TC03 Get the message at the UA- and AFTN terminals of SUT-B.		
Test control:	Check the correct reception of the message by IUTBFTNA, IUTBFTNB and IUTBMHSA, IUTBMHSB in the IUT-B configuration.		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT501	**Distribute an IPM to AMHS and AFTN users**		
Test-case id: **IT501/TC04**	Tested functionality: Distribution of IPM A message will be sent from a UA on IUT-B to IUT-A with Primary Recipients and Copy Recipients, addressing AFTN terminals and UAs in IUT-A.		
Test description:	From IUTBMHSA send the following message to: Primary Recipients: IUTAMHSA and IUTAFTNA Copy Recipients: IUTAMHSB and IUTAFTNB PRI: FF FT: <FT> TEST IT501/TC04 Get the message at the UA- and AFTN terminals of SUT-A.		
Test control:	Check the correct reception of the message by IUTAFTNA, IUTAFTNB and IUTAMHSA, IUTAMHSB in the IUT-A configuration.		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT501	**Distribute an IPM to AMHS and AFTN users**		
Test-case id: **IT501/TC05**	Tested functionality: Distribution of IPM A message will be sent from a UA on IUT-A to IUT-B with Primary Recipients, Copy Recipients and Blind Copy Recipients, addressing AFTN terminals and UAs in IUT-B.		
Test description:	From IUTAMHSA send the following message to: Primary Recipients: IUTBMHSA and IUTBFTNA Copy Recipients: IUTBMHSB and IUTBFTNB Blind Copy Recipients: IUTBMHSC and IUTBFTNC PRI: FF FT: <FT> TEST IT501/TC05 Get the message at the UA- and AFTN terminals of SUT-B.		
Test control:	Check that at the AFTN Station of IUT-B one message with addresses IUTBFTNA, IUTBFTNB and another message with the address IUTBFTNC is received. Check that at the UA IUTBMHSA one IPM is received which contains the Primary Recipients IUTBMHSA, IUTBFTNA and the Copy Recipients IUTBMHSB, IUTBFTNB, but no Blind Copy Recipients. Check that at the UA IUTBMHSC one IPM is received which contains the Primary Recipients IUTBMHSA, IUTBFTNA, the Copy Recipients IUTBMHSB, IUTBFTNB and one Blind Copy Recipient IUTBMHSC.		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT501	**Distribute an IPM to AMHS and AFTN users**
Test-case id: **IT501/TC06**	Tested functionality: Distribution of IPM A message will be sent from a UA on IUT-B to IUT-A with Primary Recipients, Copy Recipients and Blind Copy Recipients, addressing AFTN terminals and UAs in IUT-A.
Test description:	From IUTBMHSA send the following message to: Primary Recipients: IUTAMHSA and IUTAFTNA Copy Recipients: IUTAMHSB and IUTAFTNB Blind Copy Recipients: IUTAMHSC and IUTAFTNC PRI: FF FT: <FT> TEST IT501/TC06 Get the message at the UA- and AFTN terminals of SUT-A.

IT501	**Distribute an IPM to AMHS and AFTN users**		
Test control:	Check that at the AFTN Station of IUT-A one message with addresses IUTAFTNA, IUTAFTNB and another message with the address IUTAFTNC is received. Check that at the UA IUTAMHSA one IPM is received which contains the Primary Recipients IUTAMHSA, IUTAFTNA and the Copy Recipients IUTAMHSB, IUTAFTNB, but no Blind Copy Recipients. Check that at the UA IUTAMHSC one IPM is received which contains the Primary Recipients IUTAMHSA, IUTAFTNA, the Copy Recipients IUTAMHSB, IUTAFTNB and one Blind Copy Recipient IUTAMHSC.		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT502	**Expand a DL addressing both AMHS and AFTN users**		
Test-case id: **IT502/TC01**	Tested functionality: Expanding of Distribution list. The message will be sent from a UA on IUT-A addressing a local DL which contains addresses of AFTN terminals and the UA in IUT-B.		
Test description:	IUTADLLO must be configured as a local DL entry in IUT-A containing the addresses IUTBFTNA IUTBFTNB and IUTBMHSA. From IUTAMHSA send the following message to IUTADLLO: PRI: FF FT: <FT> TEST IT502/TC01 Get the message at the UA and AFTN terminals of IUT-B.		
Test control:	Check the correct reception of the message by AFTN terminals IUTBFTNA, IUTBFTNB and UA IUTBMHSA in the IUT-B configuration.		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT502	**Expand a DL addressing both AMHS and AFTN users**
Test-case id: **IT502/TC02**	Tested functionality: Expanding of Distribution list The message will be sent from a UA on IUT-B addressing a local DL which contains addresses of AFTN terminals and the UA in IUT-A.
Test description:	IUTBDLLO must be configured as a local DL entry in IUT-A containing the addresses IUTAFTNA, IUTAFTNB and IUTAMHSA. From IUTBMHSA send the following message to IUTBDLLO: PRI: FF FT: <FT> TEST IT502/TC02 Get the message at the UA and AFTN terminals of IUT-A.

IT502	**Expand a DL addressing both AMHS and AFTN users**		
Test control:	Check the correct reception of the message by AFTN terminals IUTAFTNA, IUTAFTNB and UA IUTAMHSA in the IUT-A configuration.		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT502	**Expand a DL addressing both AMHS and AFTN users**		
Test-case id: **IT502/TC03**	Tested functionality: Expanding of Distribution list The message will be sent from a UA on IUT-A addressing a remote DL in IUT-B which contains addresses of AFTN terminals and the UA in IUT-B		
Test description:	IUTBDLRE must be configured as a local DL entry in IUT-B containing the addresses IUTBFTNA, IUTBFTNB and IUTBMHSA. From IUTAMHSA send the following message to IUTBDLRE: PRI: FF FT: <FT> TEST IT502/TC03 Get the message at the UA and AFTN terminals of IUT-B.		
Test control:	Check the correct reception of the message by AFTN terminals IUTBFTNA, IUTBFTNB and UA IUTBMHSA in the IUT-B configuration.		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT502	**Expand a DL addressing both AMHS and AFTN users**		
Test-case id: **IT502/TC04**	Tested functionality: Expanding of Distribution list The message will be sent from a UA on IUT-B addressing a remote DL in IUT-A which contains addresses of AFTN terminals and the UA in IUT-A		
Test description:	IUTADLRE must be configured as a local DL entry in IUT-A containing the addresses IUTAFTNA, IUTAFTNB and IUTAMHSA. From IUTBMHSA send the following message to IUTADLRE: PRI: FF FT: <FT> TEST IT502/TC04 Get the message at the UA- and AFTN terminals of IUT-B.		
Test control:	Check the correct reception of the message by AFTN terminals IUTAFTNA, IUTAFTNB and UA IUTAMHSA in the IUT-A configuration.		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

<table>
<tr><th>IT503</th><th colspan="3">Convert or reject an IPM, if the ATS-message-text contains more than 1800 characters</th></tr>
<tr><td>Test-case id:
IT503/TC01</td><td colspan="3">Tested functionality: Conversion of “long” messages
A message with normal priority and length of about 4500 characters is sent from the IUT-A to the IUT-B</td></tr>
<tr><td>Test description:</td><td colspan="3">From UA IUTAMHSA of IUT-A send the following message to the AFTN terminal IUTBFTNA:
PRI: FF
FT: <FT>
OHI:
TEST IT503/TC01
TEXT 4500 CHARACTERS
123456789012345678901234567890123456789012345678901234567890123456789
123456789012345678901234567890123456789012345678901234567890123456789
123456789012345678901234567890123456789012345678901234567890123456789
…
123456789012345678901234567890123456789012345678901234567890123456789
END</td></tr>
<tr><td>Test control:</td><td colspan="3">The SARPs (3.1.2.3.5.2.1.7) specify that the message can be rejected (case a) or split into several messages (case b). If the system provides “long AFTN message” capability the message will be converted (case c).
<u>If case a is implemented:</u>
The message is not conveyed to the AFTN component.
Check the Report received at the User Agent position IUTAMHSA
Verify the following Per-Recipient-Report Non-Delivery information:
- Actual-recipient-name: MF-form address of IUTBFTNA
- reason code 1 signifies "unable-to-transfer"
- diagnostic code 7 signifies "content-too-long".
- supplementary information: "unable to convert to AFTN due to message text length".
<u>If case b is implemented:</u>
Check that IUTBFTNA receives several messages.
<u>If case c is implemented:</u>
Check that IUTBFTNA receives one message.</td></tr>
<tr><td>Test result:</td><td>PASS</td><td>FAILED</td><td>INCONCLUSIVE</td></tr>
<tr><td></td><td>a / b / c</td><td></td><td></td></tr>
</table>

IT503	**Convert or reject an IPM, if the ATS-message-text contains more than 1800 characters**		
Test-case id: **IT503/TC02**	Tested functionality: Conversion of “long” messages A message with normal priority and length of about 4500 characters is sent from the IUT-B to the IUT-A		
Test description:	From UA IUTBMHSA of IUT-B send the following message to the AFTN terminal IUTAFTNA: PRI: FF FT: <FT> OHI: TEST IT503/TC02 TEXT 4500 CHARACTERS 123456789012345678901234567890123456789012345678901234567890123456789 123456789012345678901234567890123456789012345678901234567890123456789 123456789012345678901234567890123456789012345678901234567890123456789 … 123456789012345678901234567890123456789012345678901234567890123456789 END		
Test control:	The SARPs (3.1.2.3.5.2.1.7) specify that the message can be rejected (case a) or split into several messages (case b). If the system provides “long AFTN message” capability the message will be converted (case c). If case a is implemented: The message is not conveyed to the AFTN component. Check the Report received at the User Agent position IUTBMHSA Verify the following Per-Recipient-Report Non-Delivery information: - Actual-recipient-name: MF-form address of IUTAFTNA - reason code 1 signifies "unable-to-transfer" - diagnostic code 7 signifies "content-too-long". - supplementary information: "unable to convert to AFTN due to message text length". If case b is implemented: Check that IUTAFTNA receives several messages. If case c is implemented: Check that IUTAFTNA receives one message.		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**
	a / b / c		

<table>
<tr><th>IT504</th><th colspan="3">Split an incoming IPM addressing more than 21 AFTN users</th></tr>
<tr><td>Test-case id:
IT504/TC01</td><td colspan="3">Tested functionality: Conversion of messages with more than 21 addresses
A message with normal priority containing 50 recipients is sent from the IUT-A to the IUT-B.</td></tr>
<tr><td>Test description:</td><td colspan="3">From IUTAMHSA send the following message to the following addressees (all recipients in the corresponding MF-Form):
IUTBFTNA, IUTBFTNB, IUTBFTNC, IUTBFTND, IUTBFTNE, IUTBFTNF, IUTBFTNG, IUTBFTNH, IUTBFTNI, IUTBFTNJ, IUTBFTNK, IUTBFTNL, IUTBFTNM, IUTBFTNN, IUTBFTNO, IUTBFTNP, IUTBFTNQ, IUTBFTNR, IUTBFTNS, IUTBFTNT, IUTBFTNU, IUTBFTNV, IUTBFTNW, IUTBFTNX, IUTBFTNY,
IUTBFTAA, IUTBFTAB, IUTBFTAC, IUTBFTAD, IUTBFTAE, IUTBFTAF, IUTBFTAG, IUTBFTAH, IUTBFTAI, IUTBFTAJ, IUTBFTAK, IUTBFTAL, IUTBFTAM, IUTBFTAN, IUTBFTAO, IUTBFTAP, IUTBFTAQ, IUTBFTAR, IUTBFTAS, IUTBFTAT, IUTBFTAU, IUTBFTAV, IUTBFTAW, IUTBFTAX, IUTBFTAY
PRI: FF
FT: <FT>
OHI:
TEST IT504/TC01</td></tr>
<tr><td>Test control:</td><td colspan="3">PDR M4050004 (Title: AMHS - Too Many Recipients) is resolved. Therefore the message shall be split into several messages.
The message is split into 3 copies, each conveyed to the AFTN component.
The first copy is addressed to 21 of the 50 addressee indicators.
The second copy is addressed to further 21 addressee indicators.
The third copy is addressed to the remaining 8 of the 50 addressee indicators.
Check the correct reception of the messages on the AFTN terminal of IUT-B.</td></tr>
<tr><td>Test result:</td><td>PASS</td><td>FAILED</td><td>INCONCLUSIVE</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>

IT504	Split an incoming IPM addressing more than 21 AFTN users		
Test-case id: **IT504/TC02**	Tested functionality: Conversion of messages with more than 21 addresses A message with normal priority containing 50 recipients is sent from the IUT-B to the IUT-A.		
Test description:	From IUTBMHSA send the following message to the following addressees (all recipients in the corresponding MF-Form): IUTAFTNA, IUTAFTNB, IUTAFTNC, IUTAFTND, IUTAFTNE, IUTAFTNF, IUTAFTNG, IUTAFTNH, IUTAFTNI, IUTAFTNJ, IUTAFTNK, IUTAFTNL, IUTAFTNM, IUTAFTNN, IUTAFTNO, IUTAFTNP, IUTAFTNQ, IUTAFTNR, IUTAFTNS, IUTAFTNT, IUTAFTNU, IUTAFTNV, IUTAFTNW, IUTAFTNX, IUTAFTNY, IUTAFTAA, IUTAFTAB, IUTAFTAC, IUTAFTAD, IUTAFTAE, IUTAFTAF, IUTAFTAG, IUTAFTAH, IUTAFTAI, IUTAFTAJ, IUTAFTAK, IUTAFTAL, IUTAFTAM, IUTAFTAN, IUTAFTAO, IUTAFTAP, IUTAFTAQ, IUTAFTAR, IUTAFTAS, IUTAFTAT, IUTAFTAU, IUTAFTAV, IUTAFTAW, IUTAFTAX, IUTAFTAY PRI: FF FT: <FT> OHI: TEST IT504/TC02		
Test control:	PDR M4050004 (Title: AMHS - Too Many Recipients) is resolved. Therefore the message shall be split into several messages. The message is split into 3 copies, each conveyed to the AFTN component. The first copy is addressed to 21 of the 50 addressee indicators. The second copy is addressed to further 21 addressee indicators. The third copy is addressed to the remaining 8 of the 50 addressee indicators. Check the correct reception of the messages on the AFTN terminal of IUT-A.		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT505	Probe Conveyance Test
Test-case id: **IT505/TC01**	Tested functionality: Processing of Probe Messages by UA and MTCU. The messages will be sent from a UA on IUT-A to IUT-B, addressing AFTN terminals and UAs in IUT-B.
Test description:	From IUTAMHSA send a probe to IUTBFTNA, IUTBFTNB, IUTBMHSA.

IT505	**Probe Conveyance Test**		
Test control:	On IUT-A UA IUTAMHSA: One Delivery Report (DR) with 2 AFTN recipients from the MTCU and one DR with one recipient from the MTA Verify that the DR reporting about the AFTN addresses contains the supplementary information "This report only indicates successful (potential) conversion to AFTN, not delivery to a recipient".		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT505	**Probe Conveyance Test**		
Test-case id: **IT505/TC02**	Tested functionality: Processing of Probe Messages by UA and MTCU. The messages will be sent from a UA on IUT-B to IUT-A, addressing AFTN terminals and UAs in IUT-A.		
Test description:	From IUTBMHSA send a probe to IUTAFTNA, IUTAFTNB, IUTAMHSA.		
Test control:	On IUT-B UA IUTBMHSA: One Delivery Report (DR) with 2 AFTN recipients from the MTCU and one DR with one recipient from the MTA Verify that the DR reporting about the AFTN addresses contains the supplementary information "This report only indicates successful (potential) conversion to AFTN, not delivery to a recipient".		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT505	**Probe Conveyance Test**
Test-case id: **IT505/TC03**	Tested functionality: Processing of Probe Messages by UA and MTCU. The messages will be sent from a UA on IUT-A to IUT-B, containing the address of an AFTN terminal of IUT-B and an MF address which cannot be translated by the MTCU of IUT-B.
Test description:	From IUTAMHSA send a probe to IUTBFTNA, IUTBFTUU (address is not provided in the look-up table of IUT-B).

IT505	Probe Conveyance Test		
Test control:	Verify that at UA IUTAMHSA: A Delivery Report, containing the reported recipient IUTBFTNA and a NDR, containing the reported recipient IUTBFTUU, with: - non-delivery-reason-code set to “unable-to-transfer”, - non-delivery-diagnostic-code set to “unrecognized-OR-name” are received. Verify that the DR reporting about the address which could be translated contains the supplementary information “This report only indicates successful (potential) conversion to AFTN, not delivery to a recipient”.		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT505	Probe Conveyance Test		
Test-case id: **IT505/TC04**	Tested functionality: Processing of Probe Messages by UA and MTCU. The messages will be sent from a UA on IUT-B to IUT-A, containing the address of an AFTN terminal of IUT-A and an MF address which cannot be translated by the MTCU of IUT-A.		
Test description:	From IUTBMHSA send a probe to IUTAFTNA, IUTAFTUU (address is not provided in the look-up table of IUT-A)		
Test control:	Verify that at UA IUTBMHSA: A Delivery Report, containing the reported recipient IUTAFTNA and a NDR, containing the reported recipient IUTAFTUU, with: - non-delivery-reason-code set to “unable-to-transfer”, - non-delivery-diagnostic-code set to “unrecognized-OR-name” are received. Verify that the DR reporting about the address which could be translated contains the supplementary information “This report only indicates successful (potential) conversion to AFTN, not delivery to a recipient”.		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

2.12.7 Stress traffic situations

IT601	**Stress load**		
Test-case id: **IT601/TC01**	Tested functionality: AMHS traffic interchange after queuing of an amount of messages After queuing of an amount of messages both IUTs start sending a burst of messages		
Test description:	Interrupt the connection between IUT-A and IUT-B by disabling the physical connector used to send information to the underlying network in one of the IUTs. Select from the data base or generated by the UA and/or the AFTN terminal 100 messages in both IUTs. For example, from IUTAFTNA send 100 messages to IUTBFTNA, IUTBMHSA. and from IUTBFTNA send 100 messages to IUTAFTNA, IUTAMHSA, In the result on IUT-A and IUT-B there are 100 messages queued in direction to the peer IUT. Re-establish the connection between IUT-A and IUT-B. The queued messages will be sent simultaneously from both IUTs. Measure the time: from re-establishing the connection till sending the first message and from sending the first message till sending the last message. Measure the time: from re-establishing the connection till receiving the first message and from receiving the first message till receiving the last message.		
Test control:	Check that all 100 messages are received at the addressed terminals. Check that no errors or malfunction are reported or observed at the IUTs during the interchange period. Analyse the measured time. Calculate at both sides the amount of time needed to flush the queues. Unacceptable delays shall be treated as “FAILED”.		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

2.12.7 The following table can be used to make notes of the Test Control Result.

Test Control	**Result IT601/TC01**	**Result IT601/TC02**	**Result IT601/TC03**
Notice the time of re-establishing the connection sending direction.			
Notice the time of sending the first message.			
Notice the time of sending the last message.			
Notice the time of re-establishing the connection receiving direction.			
Notice the time of receiving the first message.			

Test Control	Result IT601/TC01	Result IT601/TC02	Result IT601/TC03
Notice the time of receiving the last message.			
Notice the number of messages received (shall be equal to the number of messages expected.)			
Check the event logging of the system for abnormalities in the area of AMHS / X.400 / AFTN/AMHS Gateway.			
Check the event logging / traffic traces for NDRs. (No NDRs are awaited.)			
Check for Control Position events. (No related events are awaited.)			
Check the X.400 / AMHS diagnostics, check the number of associations used (in particular possible hanging/unused associations).			
Monitor the underlying network infrastructure (network specialist).			
At both sides note the amount of time needed to flush the queues. (Unacceptable delays shall be treated as “FAILED”)			

IT601	Stress load
Test-case id: **IT601/TC02**	Tested functionality: AMHS traffic interchange after queuing of an amount of messages After queuing of an amount of messages both IUTs start sending a burst of messages
Test description:	Interrupt the connection between IUT-A and IUT-B by disabling the physical connector used to send information to the underlying network in one of the IUTs. Select from the data base or generated by the UA and/or the AFTN terminal 200 messages in both IUTs. For example, from IUTAFTNA send 200 messages to IUTBFTNA, IUTBMHSA. and from IUTBFTNA send 200 messages to IUTAFTNA, IUTAMHSA, In the result on IUT-A and IUT-B there are 200 messages queued in direction to the peer IUT. Re-establish the connection between IUT-A and IUT-B. The queued messages will be sent simultaneously from both IUTs. Measure the time: from re-establishing the connection till sending the first message and from sending the first message till sending the last message. Measure the time: from re-establishing the connection till receiving the first message and from receiving the first message till receiving the last message.

IT601	**Stress load**		
Test control:	Check that all 200 messages are received at the addressed terminals. Check that no errors or malfunction are reported or observed at the IUTs during the interchange period. Analyse the measured time. Calculate at both sides the amount of time needed to flush the queues. Unacceptable delays shall be treated as "FAILED".		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

IT601	**Stress load**		
Test-case id: **IT601/TC03**	Tested functionality: AMHS traffic interchange after queuing of an amount of messages After queuing of an amount of messages both IUTs start sending a burst of messages		
Test description:	Interrupt the connection between IUT-A and IUT-B by disabling the physical connector used to send information to the underlying network in one of the IUTs. Select from the data base or generated by the UA and/or the AFTN terminal 400 messages in both IUTs. For example, from IUTAFTNA send 400 messages to IUTBFTNA, IUTBMHSA. and from IUTBFTNA send 400 messages to IUTAFTNA, IUTAMHSA, In the result on IUT-A and IUT-B there are 400 messages queued in direction to the peer IUT. Re-establish the connection between IUT-A and IUT-B. The queued messages will be sent simultaneously from both IUTs. Measure the time: from re-establishing the connection till sending the first message and from sending the first till sending the last message. Measure the time: from re-establishing the connection till receiving the first message and from receiving the first message till receiving the last message.		
Test control:	Check that all 400 messages are received at the addressed terminals. Check that no errors or malfunction are reported or observed at the IUTs during the interchange period. Analyse the measured time. Calculate at both sides the amount of time needed to flush the queues. Unacceptable delays shall be treated as "FAILED".		
Test result:	**PASS**	**FAILED**	**INCONCLUSIVE**

2.13 **Analysis of the results and second stage of tests**

2.13.1 When the tests were finished, the obtained results will be analyzed, it putting special approach in those tests where faults will have been detected.

2.13.2 It's prudent to execute those failed tests again and to verify the repetition of the inconveniences. If these are reiterated, the involved State should take the necessary measures to correct those errors.

2.13.3 When the system with problems appears to have solved its inconveniences, the involved State asked for the renewal of the tests.

2.13.4 During this second phase it should put special attention to the solution verification of the points with faults. However, once verified this, he is recommendable to return to execute the rest of the tests.

2.14 Final tests document

2.14.1 Once they were completed the totality of satisfactorily bilateral tests, it is necessary to leave a registration of the satisfactory execution of the tests, by means of a combined document that guarantees to the personnel that later they will made the operative integration, that all the previous necessary preventions were adopted to guarantee the prospective functionalities.

3. SECOND PART (OPERATIVE INTEGRATION)

3.1 Aspects to be considered for operative integration

3.1.1 *Analysis of the test results of AMHS Interconnection*

3.1.1.1 Must be perfectly clear that it is not possible to advance in operative integration until the interconnection tests have not solved all the points with fault.

3.1.1.2 It's to hope that two administrations that have systems of one same supplier do not present inconveniences in the interconnection.

3.1.1.3 Anyway, these administrations had to make the tests at issue, to avoid later potentials difficulties.

3.1.2 *AMHS Services*

3.1.2.1 The States will have to inform (to confirm) if they have:

a) Basic ATS service, which provides AFTN equivalent functionalities,
b) Extended ATS service, which provides additional services and facilities, including security based on digital signature, binary attachment, big attachments, ATN Directory.

3.1.3 *AMHS address Scheme*

3.1.3.1 If well this action is previous at the beginning of the interconnection tests, each State will have to reconfirm to the other state the definitive AMHS address scheme:

a) CAAS "O" Simple,
b) CAAS "O" Multiple,
c) XF.

3.1.3.2 In the SAM Region, the AMHS addressing scheme adopted for all States is the CAAS.

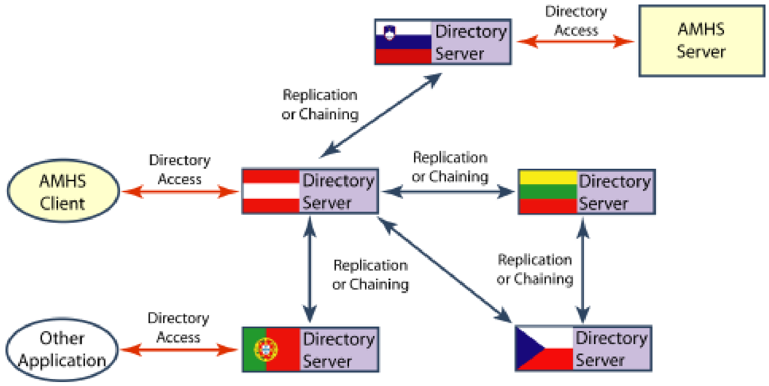
3.1.3.3 States that have installed or are in process of installing same, must register at the AMC (AMHS management centre) following the procedure specified in ICAO State letter AN 7/49.1-09/34 of 14 April 2009. The AMC will manage AMHS addressing off-line globally.

3.1.4 *Directory Service (DS)*

3.1.4.1 When being interconnected, each DS will be able "*to see*" to its adjacent pair, with which the UA will be able to access not only to his State Directory, also it will can to access to the adjacent (s).

3.1.4.2 Is important to use the DS "*shadowing*" functionality, which allows to one of the Directories to have a "copy" of the other, to which will have to consult regularly to maintain updated its data base.

3.1.4.3 At this respect, following it is inserted a schematic image of this operation:



3.1.4.4 In that order, it will be due to anticipate the configuration, in each extreme, the period with each DS will refresh the data from his adjacent (s) pair(s), considering that the increase in the rate of refreshment inevitably will increase the bandwidth to be used.

3.1.5 *National and intraregional IP address*

3.1.5.1 *Protocol*: as outside established in the IP Address Regional Plan:

a) Initially, IPv4 will be used.

b) Each State will be able to use, in its internal frame, the directions assigned in this plan, those that are enclosed like Appendix A. Those States that does not use them nationally, they will have to assure the use of the same ones by means of the NAT functionality.

3.1.5.2 *Border routers (BIS) links doors:* each State should have to use the established at IP Address Regional Plan, already presented in Part 1.

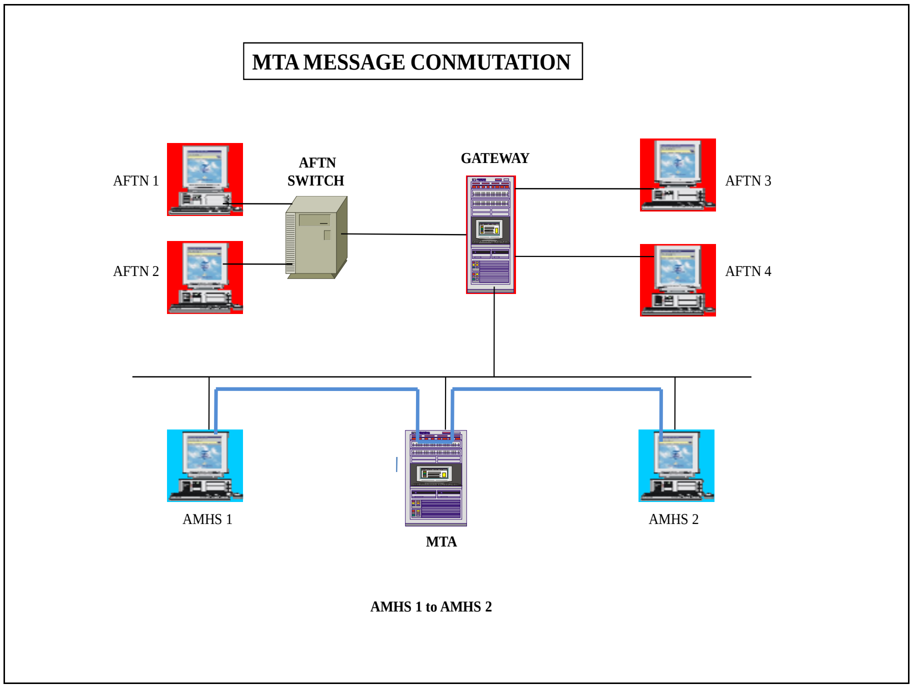
3.1.5.3 *MTA Address*: each State will have to inform this direction, according to the address determined by the established national allocation in the mentioned Regional Plan.

3.1.6 *Messages Commutation*

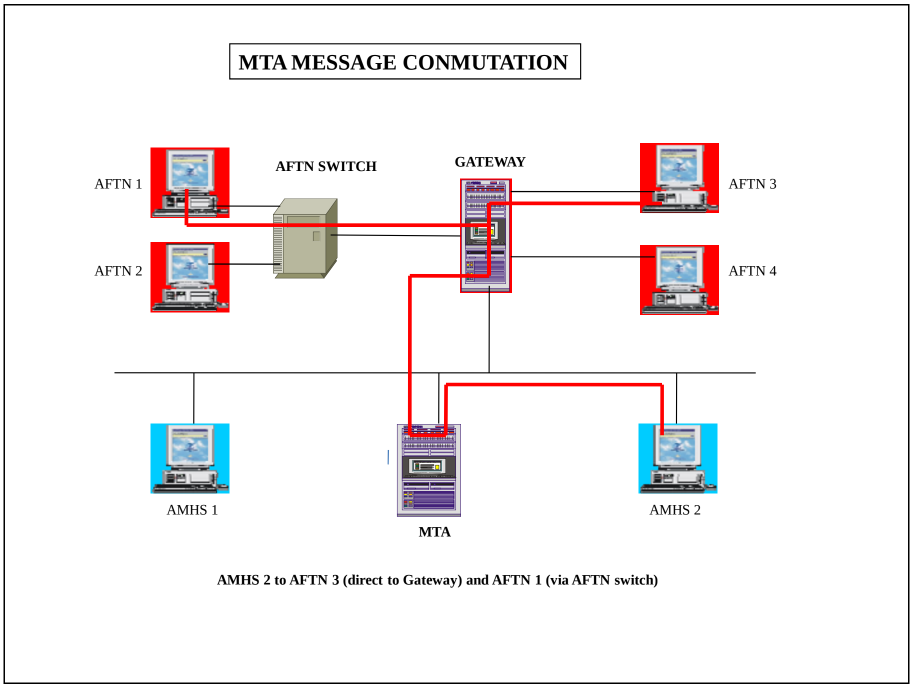
3.1.6.1 Existing AMHS systems allow *two* modalities of messages commutation:

a) All the messages are exchanged by the MTA, without mattering that they exist AFTN terminal, or that these are connected to the Gateway or by interval AFTN switch. In that order, it exist three basic commutation classes: AMHS (UA) to AMHS (UA), AMHS (UA) to AFTN and AFTN to AFTN.

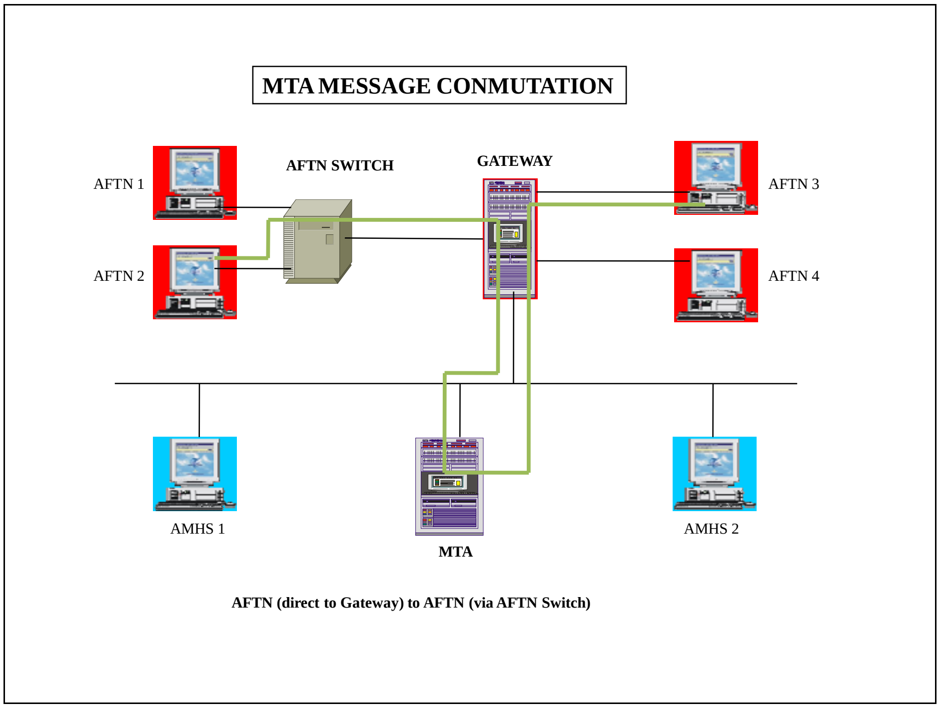
- *Case 1: UA to UA (*The heavy blue line indicates the messages flow towards both sides).



- *Case 2: UA to AFTN (and vice versa) (*The heavy red line indicates the messages flow towards both sides).



- *Case 3: AFTN to AFTN (*The heavy green line indicates the messages flow towards both sides).



b) MTA exchanges only messages corresponding to UA, whereas the Gateway exchanges (without the participation of the MTA) all the messages that do not leave their AFTN area, that is it works like an AFTN switch.

3.1.6.2 To this respect, it must be clear that *only the first case* is applicable to AMHS integration, since the second case would prevent that the DS was complete, since it would interchange with the other adjacent States a single part of the totality of the necessary O/R.

3.1.7 *Bandwidth to be used*

3.1.7.1 Although this factor in principle do not pretend to be important, it will have to become the necessary adjustments with the supplier of the transport network (REDDIG, MEVA II) to assure that, at the time of integration, a DLCI of 64K between border routers of each State is formed.

3.1.8 I*ntegration Scenarios*

3.1.8.1 The scenarios will differ, basically, if integration were made between States that have completed their UAs' deploy in his territory, and those that have done it partially.

3.1.8.2 To the effects to deep in this subject, it is assumed that:

a) Three are the involved states, where two of them have been changed to the AMHS (A and B), whereas one of them (C), remains in AFTN.

b) Two which they changed to AMHS have chosen CAAS, "O" simple.

c) The name of the MTA of State A is MTA=AAA.

d) The name of the MTA of State B is MTA=BBB.

e) State C remains in AFTN.

f) With respect to the attributes of the UAs address (X.400), it is used the following convention:

- C=XX /ADMD=ICAO/ PRMD=S* /O=IUT*/ OU1= IUT*/ CN=IUT*MHS* (for AMHS terminals)

- C=XX/ ADMD=ICAO/ PRMD=S*/ O=Gateway/ CN=IUT*FTN* (for AFTN terminals)

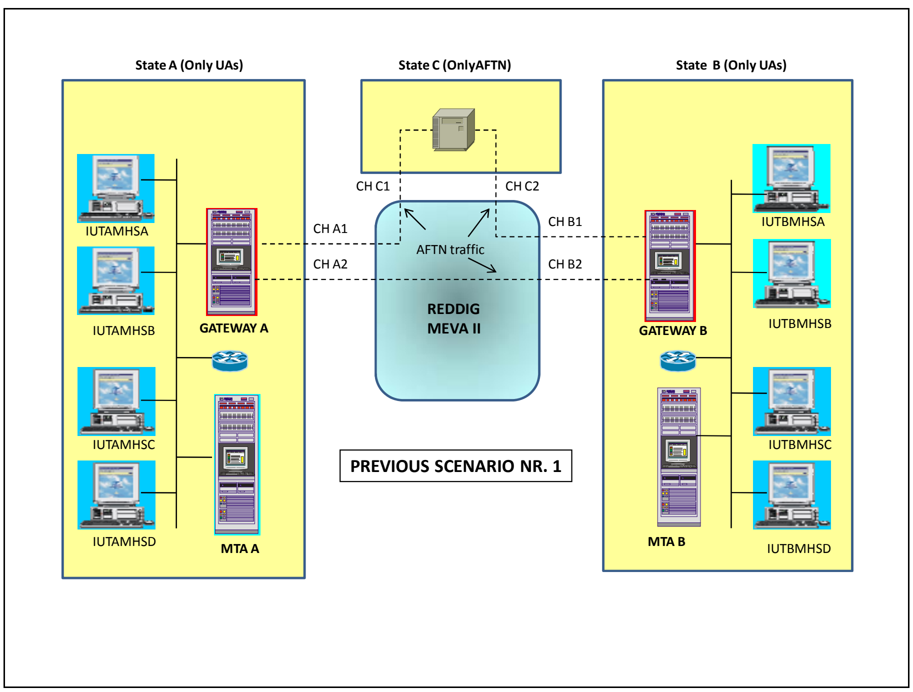
g) The sign * represents the letters A or B, according to corresponds,

h) CH *: it indicates the number of associated AFTN channel, to the Gateway and/or associate AFTN switch.

3.2 Scenarios for operative integration

3.2.1 **TYPE 1**: *State A with complete national development, with State B with complete national development*

3.2.1.1 Previous scenario to integration



3.2.1.2 From the scheme can be observed the following routing and address scheme:

a) For State A

State	Routing and X.400 address							AFTN Routing			
	MTA	C	ADMD	PRMD	O	OU1	CN	Gateway	CH	Switch	CH
A	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSA				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSB				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSC				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSD				
								IUTC ****	A1		
								IUTB ****	A2		

b) For State B

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	O	OU1	CN	Gateway	CH	Switch	CH
B	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSA				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSB				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSC				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSD				
								IUTC ****	B1		
								IUTA ****	B2		

c) For State C

State	Routing and X.400 directory							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
C										IUTA****	C1
										IUTB****	C2

3.2.1.3 Actions to execute for integration:

a) According to the previous fixed convention, to the State A corresponds PRMD=SA, while to state B corresponds PRMD=SB.

b) For this case, and with respect to **routing**, in each State the following main actions will have to be executed:

- In the configuration of MTA=AAA (State A), it's necessary to add in the tree the data corresponding to State B, that is C=XX, ADMD=ICAO, PRMD=SB, so it will be program that the corresponded routing will not be do by himself, it will make by the adjacent MTB=BBB.

- Vice versa, in the configuration of MTA=BBB (State B), it's necessary to add in the tree the data corresponding to State A, that is C=XX, ADMD=ICAO, PRMD=SA, so it will be program that the corresponded routing will not be do by himself, it will make by the adjacent MTB=AAA.

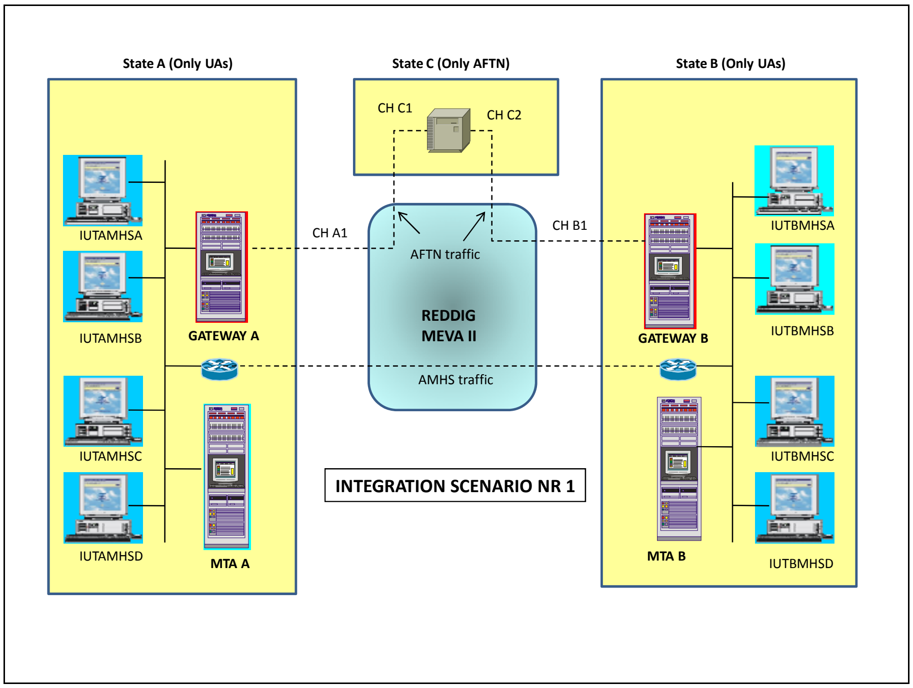
- In the routing configuration of the State A Gateway, the address corresponding to SB****** will be eliminated, staying routing SC ******.

- Vice versa, in the routing configuration of the State B Gateway, the address corresponding to SA****** will be eliminated, staying routing SC ******.

c) With respect to **Directory**, the commentaries indicated previously are been worth, in Chapter "Directory Service".

3.2.1.4 Scenario following to integration

a) According to the adopted actions, the following graphical scheme and tables from routing and directory are:



- For State A

State	Routing and X.400 directory							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
A	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSA				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSB				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSC				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSD				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSA				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSB				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSC				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSD				
								IUTC ***	A1		

- For State B

State	Routing and X.400 directory							Routing AFTN			
		C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
B	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSA				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSB				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSC				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSD				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSA				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSB				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSC				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSD				
								IUTC****	B1		

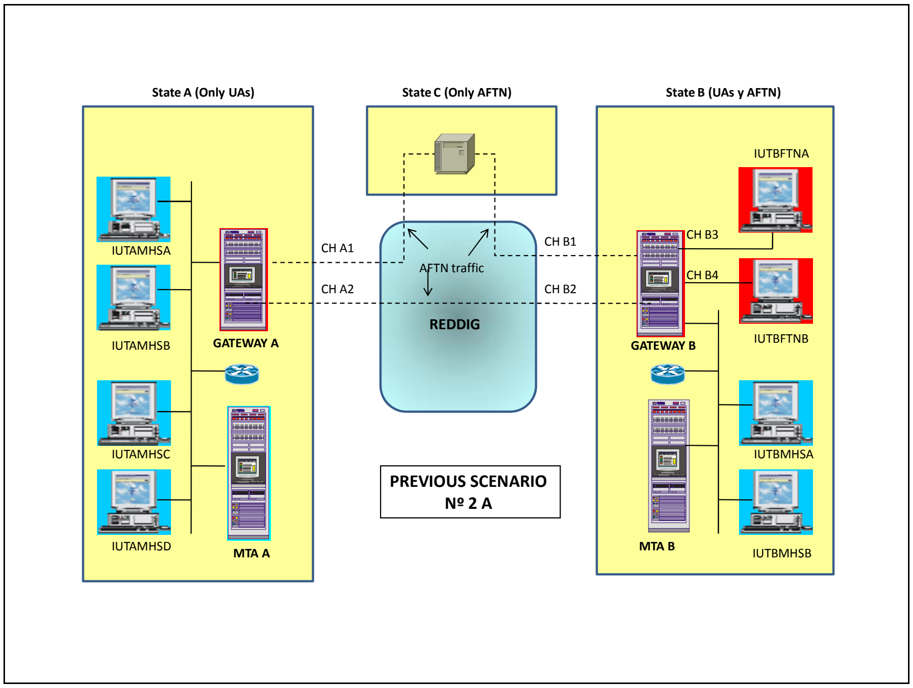
- For State C

State	Routing and X.400 directory							Routing AFTN			
		C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
C										IUTA****	C1
										IUTB****	C2

3.2.2 **TYPE 2** *State A with complete national development with State B with partial national development.* Although it exist several intermediate possible cases, it distinguish two greater cases, those they appear to continuation:

3.2.2.1 **Case 2A** *AFTN terminals connected to the Gateway*

a) *Previous scenario to integration:* Of the scheme it can be observed the following scheme of routing and address:



- For State A

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
A	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSA				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSB				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSC				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSD				
								IUTC ****	A1		
								IUTB ****	A2		

- For State B

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
B	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSA				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSB				
	BBB	XX	ICAO	SB	Gateway		IUTBFTNA	IUTBFTNA	B3		
	BBB	XX	ICAO	SB	Gateway		IUTBFTNB	IUTBFTNB	B4		
								IUTC ****	B1		
								IUTA ****	B2		

- For State C

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
C										IUTA****	C1
										IUTB ****	C2

b) *Actions to execute for integration*

- According to the previous fixed convention, to the State A corresponds PRMD=SA, while to state B corresponds PRMD=SB.

- For this case, and with respect to **routing**, in each State the following main actions will have to be executed :

  In the configuration of MTA=AAA (State A), it's necessary to add in the tree the data corresponding to State B, that is C=XX, ADMD=ICAO, PRMD=SB, so it will be program that the corresponded routing will not be do by himself, it will make by the adjacent MTB=BBB.

  Vice versa, in the configuration of MTA=BBB (State B), it's necessary to add in the tree the data corresponding to the State A, that is C=XX, ADMD=ICAO, PRMD=SA, so it will be program that the corresponded routing will not be do by, it will make the by adjacent MTA=AAA.

  In the configuration of routing of the State A Gateway, the address corresponding to SB****** will be eliminated, staying routing SC******.

  Vice versa, in the configuration of routing of the Gateway of State B, the address corresponding to SA****** will be eliminated, staying routing SC ******.

- With respect to **Directory**, the commentaries indicated previously are been worth, in Chapter "Directory Service". Addtionally, it must consider that:

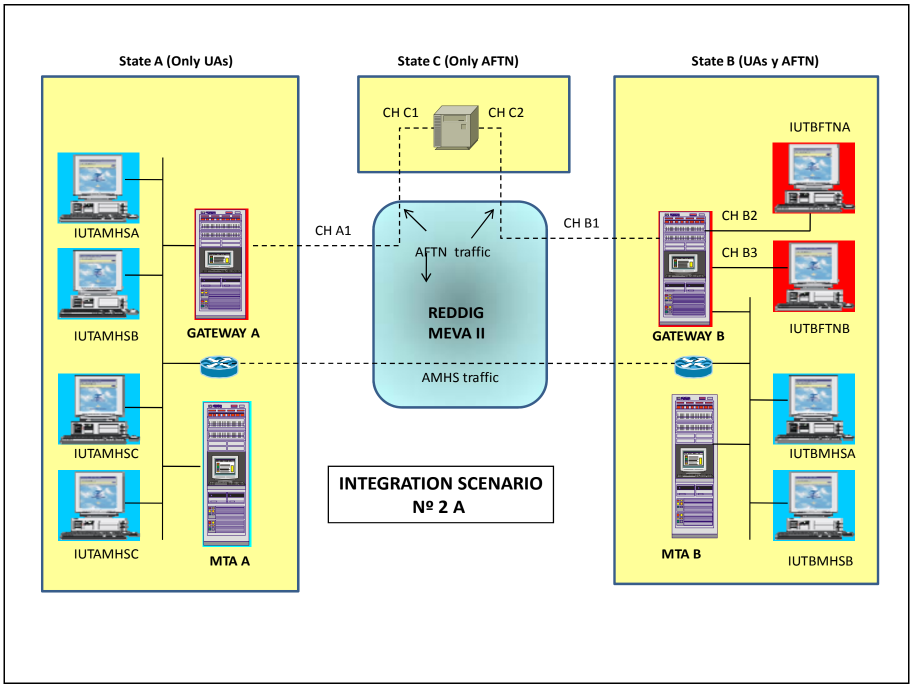
  At the moment of integration, each DS will copy the one of their pair.

  After, within the integrated operation, the State A will not undergo greater changes than the attributable ones to the entrance of new users or the elimination of these.

  However, the situation in State B is different since, in addition to the presented cases for A, each migration of one AFTN terminal to AMHS in his own territory will implied a modification in his own routing as in his own Directory.

If although it will be remembered a periodic "refresh" between the DS, the action previously mentioned will commited to State B informs beforehand to the State A whenever B produces a modification in its internal frame; in this way A will adopt the necessary measures to update its own Directory in manual form, without waiting for automatic "refresh".

c) *Later scenario to integration:* in agreement to the adopted actions, it results the following graphical scheme and tables of routing and directory



- For State A

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
A	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSA				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSB				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSC				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSD				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSA				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSB				
	BBB	XX	ICAO	SB	Gateway		IUTBFTNA				
	BBB	XX	ICAO	SB	Gateway		IUTBFTNB				
								IUTC ****	A1		
								IUTB ****	A2		

- For State B

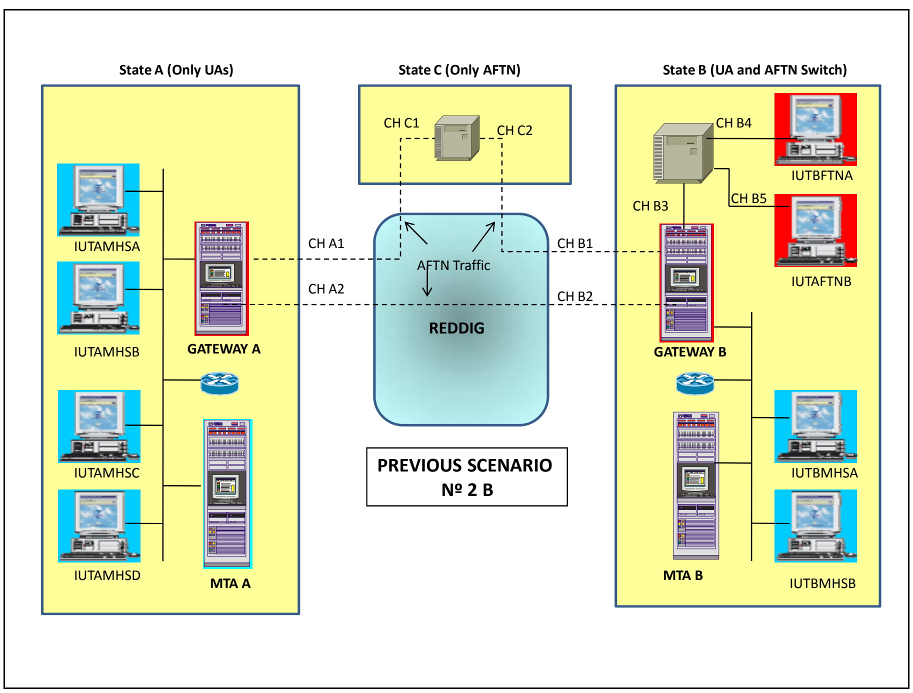
State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
B	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSA				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSB				
	BBB	XX	ICAO	SB	Gateway		IUTBFTNA	IUTBFTNA	B3		
	BBB	XX	ICAO	SB	Gateway		IUTBFTNB	IUTBFTNB	B4		
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSA				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSB				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSC				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSD				
								IUTC ****	B1		
								IUTA ****	B2		

- For State C

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
C										IUTA ****	C1
										IUTB ****	C2

3.2.2.2 **Case 2B** *AFTN terminals connected to the AFTN switch*

a) *Previous scenario to integration*: from the scheme it can be observed the following tables of routing and address:



- For State A

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OrU1	Cnn	Gateway	CH	Switch	CH
A	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSA				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSB				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSC				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSD				
								IUTC ****	A1		
								IUTB ****	A2		

- For State B

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
B	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSA				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSB				
	BBB	XX	ICAO	SB	Gateway		IUTBFTNA	IUTBFTNA	B3		
	BBB	XX	ICAO	SB	Gateway		IUTBFTNB	IUTBFTNB			
								IUTC ****	B1		
								IUTA ****	B2		
										IUTBFTNA	B4
										IUTBFTNB	B5

- For State C

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
C										IUTA ****	C1
										IUTB ****	C2

b) *Actions to execute for integration*

- According to the previous fixed convention, to the State A corresponds PRMD=SA, while to state B corresponds PRMD=SB.

- For this case, and with respect to **routing**, in each State the following main actions will have to be executed :

  In the configuration of MTA=AAA (State A), it's necessary to add in the tree the data corresponding to State B, that is C=XX, ADMD=ICAO, PRMD=SB, so it will be program that the corresponded routing will not be do by himself, it will make by the adjacent MTB=BBB.

Vice versa, in the configuration of MTA=BBB (State B), it's necessary to add in the tree the data corresponding to State A, that is C=XX, ADMD=ICAO, PRMD=SA, so it will be program that the corresponded routing will not be do by himself, it will make by the adjacent MTB=AAA.

In the configuration of routing of the State To Gateway of the, the address corresponding to SB****** will be to eliminate, staying routing SC ******.

Vice versa, in the configuration of routing of the Gateway of State B, the address corresponding to SA will be due to eliminate ******, staying routing SC ******.

- With respect to **Directory**, the commentaries indicated previously are been worth, in chapter "Directory Service". In addition, it must consider that:

  At the moment of integration, each DS copied the one of their pair.

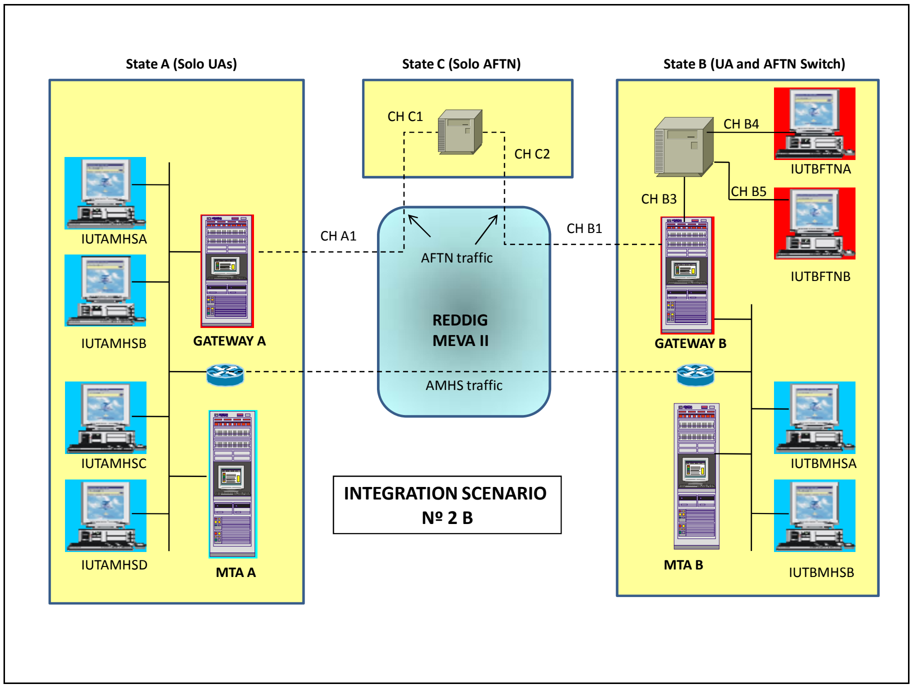
  After, within the integrated operation, the State A will not undergo greater changes than the attributable ones to the entrance of new users or the elimination of these.

  However, the situation in State B is different since, in addition to the presented cases for A, each migration of one AFTN terminal to AMHS in his own territory will implied a modification in his own routing as in his own Directory

  If although it will be remembered a periodic "refresh" between the DS, the action previously mentioned will commited to State B informs beforehand to the State A whenever B produces a modification in its internal frame; in this way A will adopt the necessary measures to update its own Directory in manual form, without waiting for automatic "refresh"

  By another part, if B decides to change of AFTN to AFTN (connection of Switch to Gateway), like a previous step to happen of AFTN to AMHS, this action does not demand a warning to A, already that does not modify the Directory of B, and therefore about A, one only is a modification of routing AFTN in B.

c) *Scene subsequent to integration:* according to the adopted actions, the following graphical scheme and the tables from routing and directory are:



- For State A

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
A	AAA	XX	ICAO	SA	IUTA	IUT A	IUTAMHS A				
	AAA	XX	ICAO	SA	IUTA	IUT A	IUTAMHSB				
	AAA	XX	ICAO	SA	IUTA	IUT A	IUTAMHSC				
	AAA	XX	ICAO	SA	IUTA	IUT A	IUTAMHS D				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSA				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSB				
	BBB	XX	ICAO	SB	Gateway		IUTBFTNA				
	BBB	XX	ICAO	SB	Gateway		IUTBFTNB				
								IUTC ****	A1		

- For State B

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
B	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSA				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSB				
	BBB	XX	ICAO	SB	Gateway		IUTBFTNA	IUTBFTNA	B3		

State	**Routing and X.400 address**							**Routing AFTN**			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
	BBB	XX	ICAO	SB	Gateway		IUTBFTNB	IUTBFTNB			
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSA				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSB				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSC				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSD				
								IUTC ****	B1		
										IUTBFTNA	B4
										IUTBFTNB	B5

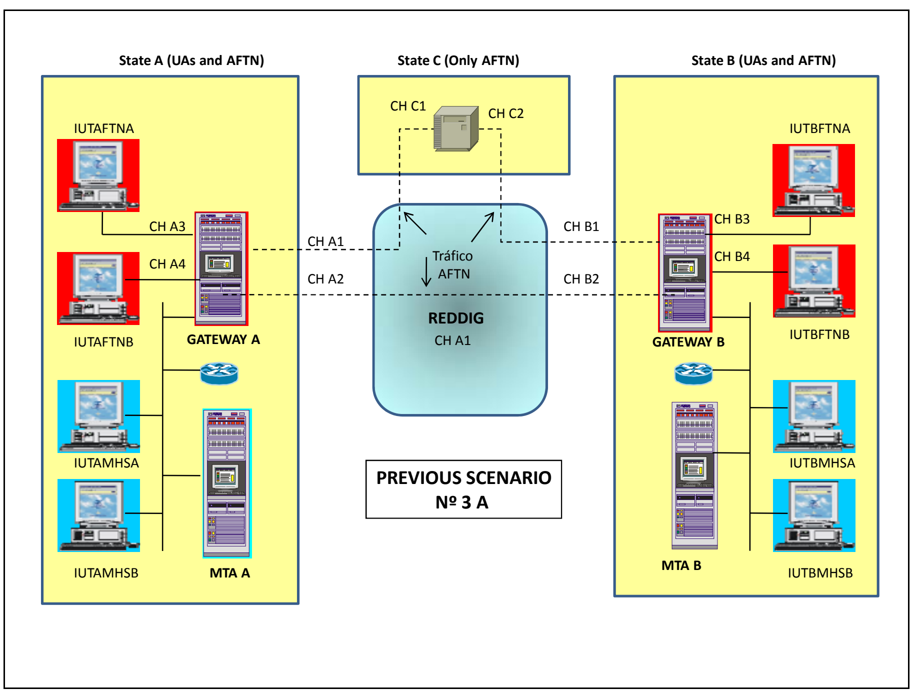
- For State C

State	**Routing and X.400 address**							**Routing AFTN**			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
C										IUTA ****	C1
										IUTB ****	C2

3.2.3 **TYPE 3** *State A with partial national development with State B with partial national development.* Like for the previous Type, several possible intermediate cases exist, two greater cases are distinguished, those than they appear next:

3.2.3.1 **Case 3A** *AFTN terminals connected to the Gateway*

a) *Previous scenario to integration*: From the scheme it can be observed the following scheme of routing and address:



- For State A

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
A	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSA				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSB				
	AAA	XX	ICAO	SB	Gateway		IUTAFTNA	IUTAFTNA	A3		
	AAA	XX	ICAO	SB	Gateway		IUTAFTNB	IUTAFTNB	A4		
								IUTC ****	A1		
								IUTB ****	A2		

- For State B

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
B	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSA				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSB				
	BBB	XX	ICAO	SB	Gateway		IUTBFTNA	IUTBFTNA	B3		
	BBB	XX	ICAO	SB	Gateway		IUTBFTNB	IUTBFTNB	B4		
								IUTC ****	B1		
								IUTA ****	B2		

- For State C

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
C										IUTA ****	C1
										IUTB ****	C2

b) *Actions to execute for integration*

- According to the previous fixed convention, to the State A corresponds PRMD=SA, whereas to state B corresponds PRMD=SB.

- For this case, and with respect to **routing**, in each State the following main actions will have to be executed:

In the configuration of MTA=AAA (State A), it's necessary to add in the tree the data corresponding to State B, that is C=XX, ADMD=ICAO, PRMD=SB, so it will be program that the corresponded routing will not be do by himself, it will make by the adjacent MTB=BBB.

Vice versa, in the configuration of MTA=BBB (State B), it's necessary to add in the tree the data corresponding to State A, that is C=XX, ADMD=ICAO, PRMD=SA, so it will be program that the corresponded routing will not be do by himself, it will make by the adjacent MTB=AAA.

In the configuration of routing of the State To Gateway of the, the address corresponding to SB****** will be to eliminate, staying routing SC ******.

Vice versa, in the configuration of routing of the Gateway of State B, the address corresponding to SA****** will be eliminate, staying routing SC ******.

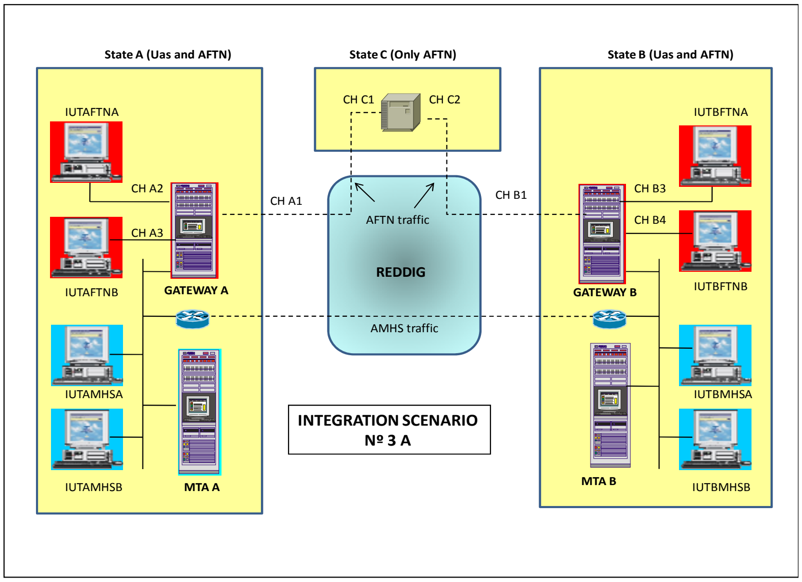
- With respect to **Directory**, the commentaries indicated previously are been worth, in chapter "Directory Service". In addition, it must consider that:

  At the moment of integration, each DS copied the one of their pair.

  The situation in the States A and B is equal, since its context is identical, by which in addition to the cases of entrance of new users or the elimination of these, each migration of a terminal to AFTN to AMHS in its territory as much implied a modification in its own routing as in its Directory,

  If although it will be remembered a periodic "refresh" between the DS, the action previously mentioned will commit to State B informs beforehand to the State A whenever B produces a modification in its internal frame; in this way A will adopt the necessary measures to update its own Directory in manual form, without waiting for automatic "refresh"

c) *Scene subsequent to integration:* in agreement to the adopted actions, is the following graphical scheme and the tables from routing and directory



- For State A

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
A	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSA				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSB				
	AAA	XX	ICAO	SB	Gateway		IUTAFTNA	IUTAFTNA	A3		
	AAA	XX	ICAO	SB	Gateway		IUTAFTNB	IUTAFTNB	A4		
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSA				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSB				
	BBB	XX	ICAO	SB	Gateway		IUTBFTNA				
	BBB	XX	ICAO	SB	Gateway		IUTBFTNB				
								IUTC ****	A1		

- For State B

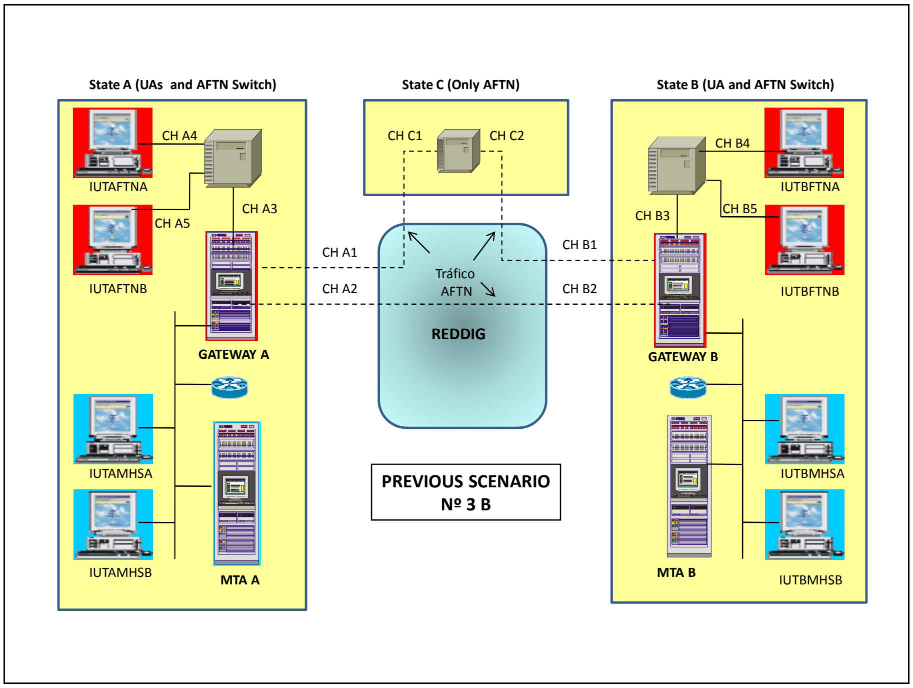
State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
B	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSA				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSB				
	BBB	XX	ICAO	SB	Gateway		IUTBFTNA	IUTBFTNA	B3		
	BBB	XX	ICAO	SB	Gateway		IUTBFTNB	IUTBFTNB	B4		
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSA				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSB				
	AAA	XX	ICAO	SB	Gateway		IUTAFTNA				
	AAA	XX	ICAO	SB	Gateway		IUTAFTNB				
								IUTC ****	B1		

- For State C

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
C										IUTA ****	C1
										IUTB ****	C2

3.2.3.2 **Case 3B**: *AFTN terminals connected to the Switch AFTN.*

a) *Previous scene to integration*: From the scheme it can be observed the following scheme of routing and address:



- For State A

State	**Routing and X.400 address**							**Routing AFTN**			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
A	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSA				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSB				
	AAA	XX	ICAO	SB	Gateway		IUTAFTNA	IUTAFTNA	A3		
	AAA	XX	ICAO	SB	Gateway		IUTAFTNB	IUTAFTNB			
								IUTC ****	A1		
								IUTB ****	A2		
										IUTAFTNA	A4
										IUTAFTNB	A5

- For State B

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
B	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSA				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSB				
	BBB	XX	ICAO	SB	Gateway		IUTBFTNA	IUTBFTNA	B3		
	BBB	XX	ICAO	SB	Gateway		IUTBFTNB	IUTBFTNB			
								IUTC ****	B1		
								IUTA ****	B2		
										IUTBFTNA	B4
										IUTBFTNB	B5

- For State C

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
C										IUTA ****	C1
										IUTB ****	C2

b) *Actions to execute for integration*

- According to the previous fixed convention, to the State A corresponds PRMD=SA, while to state B corresponds PRMD=SB.

- For this case, and with respect to **routing**, in each State the following main actions will have to be executed :

In the configuration of MTA=AAA (State A), it's necessary to add in the tree the data corresponding to State B, that is C=XX, ADMD=ICAO, PRMD=SB, so it will be program that the corresponded routing will not be do by himself, it will make by the adjacent MTB=BBB.

Vice versa, in the configuration of MTA=BBB (State B), it's necessary to add in the tree the data corresponding to State A, that is C=XX, ADMD=ICAO, PRMD=SA, so it will be program that the corresponded routing will not be do by himself, it will make by the adjacent MTB=AAA.

In the configuration of routing of the State To Gateway of the, the address corresponding to SB****** will be to eliminate, staying routing SC ******.

Vice versa, in the configuration of routing of the Gateway of State B, the address corresponding to SA****** will be eliminate, staying routing SC ******.

- With respect to **Directory**, the commentaries indicated previously are been worth, in chapter "Directory Service". In addition, it must consider that:

At the moment of integration, each DS copied the one of their pair.

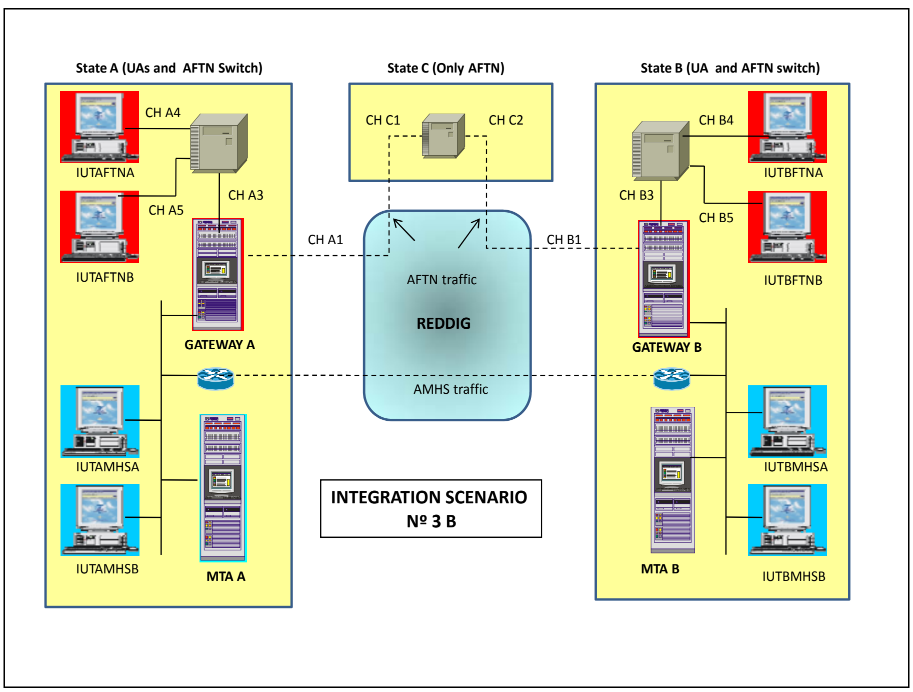
The situation in the States A and B is equal, since its context is identical, by which in addition to the cases of entrance of new users or the elimination of these, each migration of a terminal to AFTN to AMHS in its territory as much implied a modification in its own routing as in its Directory,

If although it will be remembered a periodic "refresh" between the DS, the action previously mentioned will commit to State B informs beforehand to the State A whenever B produces a modification in its internal frame; in this way A will adopt the necessary measures to update its own Directory in manual form, without waiting for automatic "refresh"

By another part, if State A decides to change of AFTN to AFTN (connection of Switch to Gateway), like previous step to happen of AFTN to AMHS, this action does not demand a warning to B, already that does not modify the Directory of A, and therefore about B, it only is a modification of routing AFTN in A.

If the one is B that decides to change of AFTN to AFTN (connection of Switch to Gateway), like previous step to happen of AFTN to AMHS, this action does not demand a warning to A, since it does not modify the Directory of B, and therefore of A, only is a modification of routing AFTN in B.

c) *Scenario subsequent to integration*: According to the adopted actions, the following graphical scheme and the tables from routing and directory are:



- For State A

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
A	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSA				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSB				
	AAA	XX	ICAO	SB	Gateway		IUTAFTNA	IUTAFTNA	A3		
	AAA	XX	ICAO	SB	Gateway		IUTAFTNB	IUTAFTNB			
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSA				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSB				
	BBB	XX	ICAO	SB	Gateway		IUTBFTNA				
	BBB	XX	ICAO	SB	Gateway		IUTBFTNB				
								IUTC ****	A1		
										IUTAFTNA	A4
										IUTAFTNB	A5

- For State B

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
B	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSA				
	BBB	XX	ICAO	SB	IUTB	IUTB	IUTBMHSB				
	BBB	XX	ICAO	SB	Gateway		IUTBFTNA	IUTBFTNA	B3		
	BBB	XX	ICAO	SB	Gateway		IUTBFTNB	IUTBFTNB			
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSA				
	AAA	XX	ICAO	SA	IUTA	IUTA	IUTAMHSB				
	AAA	XX	ICAO	SB	Gateway		IUTAFTNA				
	AAA	XX	ICAO	SB	Gateway		IUTAFTNB				
								IUTC ****	B1		
										IUTBFTNA	B4
										IUTBFTNB	B5

- For State C

State	Routing and X.400 address							Routing AFTN			
	MTA	C	ADMD	PRMD	Or	OU1	Cnn	Gateway	CH	Switch	CH
C										IUTA ****	C1
										IUTB ****	C2

3.3 **Preparatory phase**

3.3.1 *Detailed analysis of the "Aspects to consider for integration*": delegates of the States to integrate his systems will have to meet to analyze, point by point, each one of the topics detailed in corresponding Chapter, in order to assure the nonexistence factors that jeopardize the future operations.

3.3.2 *Proposal of integration according to the type of scenario*: at the time of the integration decision, each State will have to present its definitive scheme of present operation, in order to determine the modality that better complies to the joint activity.

3.3.3 *Coordination of the operational procedures*: the operational procedures to develop will have a degree of greater or smaller complexity based on the integration scene, since:

3.3.3.1 Case 1: it allows simple procedures and without greater changes to future in both directories.

3.3.3.2 Case 2: it allows simple initial procedure, but subject to many changes in the future in the directory of B.

3.3.3.3 Case 3: it allows simple initial procedure, but subject to many changes to future in both directories.

3.3.4 *Plans of contingency*: it should develop Contingency Plans that assure the smaller possible resentment in the service before eventual inconveniences in the operational phase of integration.

3.3.5 *Development of the activities cronogram*: as it is obvious, a tentative Cronogram of predicted Activities will have to appear, in order to diminish the efforts that will have to practice the States to arrive at the operational phase

3.4 **Agreements for Integration**

3.4.1 *Type in agreement*: The agreement could be I saw or multilateral,

3.5 **Phase of operative Integration**

3.5.1 *Temporary suspension of the service*: for minor that is considered or foresee the duration of the operative transition of integration, it is unavoidable the interruption of the service for a lapse that will be minimized , which will be informed to all the international users to those that serve the States A and B.

3.5.2 I*ntegrated Operation*: after having concluded the transition, and already begun the integrated operation will owe himself:

3.5.2.1 To jealously watch the operation in both States, at least during a reasonable term that assures the normal continuity the service.

3.5.2.2 To remember that this State that must progressively change AFTN terminals to AMHS, beforehand will have to inform to the other State, so this makes the forecasts to refresh its DS with the new data of its pair.

APPENDIX A

IP ADDRESS REGIONAL PLAN
ALLOCATION BY REGION AND STATE

REGION SAM

Number	State/Territory	Network	Usable Addresses	Decimal Annotation						
1	Argentina	10.0.0.0/19	First	10	.	0	.	0	.	1
			-							
			-							
			Last	10	.	0	.	31	.	254
2	Chile	10.0.32.0/19	First	10	.	0	.	32	.	1
			-							
			-							
			Last	10	.	0	.	63	.	254
3	Brazil	10.0.64.0/19	First	10	.	0	.	64	.	1
			-							
			-							
			Last	10	.	0	.	95	.	254
4	Uruguay	10.0.96.0/19	First	10	.	0	.	96	.	1
			-							
			-							
			Last	10	.	0	.	127	.	254
5	Paraguay	10.0.128.0/19	First	10	.	0	.	128	.	1
			-							
			-							
			Last	10	.	0	.	159	.	254
6	Bolivia	10.0.160.0/19	First	10	.	0	.	160	.	1
			-							
			-							
			Last	10	.	0	.	191	.	254
7	Peru	10.0.192.0/19	First	10	.	0	.	192	.	1
			-							
			-							
			Last	10	.	0	.	223	.	254
8	Ecuador	10.0.224.0/19	First	10	.	0	.	224	.	1
			-							
			-							
			Last	10	.	0	.	255	.	254
9	Colombia	10.1.0.0/19	First	10	.	1	.	0	.	1
			-							
			-							

			Last	10	.	1	.	31	.	254
10	Venezuela	10.1.32.0/19	First	10	.	1	.	32	.	1
			-							
			-							
			Last	10	.	1	.	63	.	254
11	Guyana	10.1.64.0/19	First	10	.	1	.	64	.	1
			-							
			-							
			Last	10	.	1	.	95	.	254
12	Surinam	10.1.96.0/19	First	10	.	1	.	96	.	1
			-							
			-							
			Last	10	.	1	.	127	.	254
13	French Guyana (France)	10.1.128.0/19	First	10	.	1	.	128	.	1
			-							
			-							
			Last	10	.	1	.	159	.	254
14	Panama	10.1.160.0/19	First	10	.	1	.	160	.	1
			-							
			-							
			Last	10	.	1	.	191	.	254
-	Vacancy	10.1.192.0/19	First	10	.	1	.	192	.	1
			-							
			-							
			Last	10	.	1	.	223	.	254
-	Vacancy	10.1.224.0/19	First	10	.	1	.	224	.	1
			-							
			-							
			Last	10	.	1	.	255	.	254
-	Vacancy	10.2.0.0/19	First	10	.	2	.	0	.	1
			-							
			-							
			Last	10	.	2	.	31	.	254
-	-	-	First	-						
			-	-						
			-	-						
			Last	-						
-	-	-	First	-						
			-	-						
			-	-						
			Last	-						
-	-	-	First	-						
			-	-						

			-	-						
			Last	-						
-	-	-	First	-						
			-	-						
			-	-						
			Last	-						
126 (It completes)	Reserved	10.15.224.0/19	First	10	.	15	.	224	.	1
			-							
			-							
			Last	10	.	15	.	255	.	254

APPENDIX B

MEMORANDUM OF UNDERSTANDING FOR THE INTERCONNECTION OF AMHS SYSTEMS

	MEMORANDUM OF UNDERSTANDING FOR THE INTERCONNECTION OF AMHS SYSTEMS		
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Preface

This document defines the Memorandum of Understanding for the bilateral interconnection of AMHS systems between the States of the Region. The two States may revise this document when so required.

	MEMORANDUM OF UNDERSTANDING FOR THE INTERCONNECTION OF AMHS SYSTEMS		
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Approval
Memorandum of Understanding for the Interconnection of AMHS Systems

By **State A**

By **State B**

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Revisions

Revision / Date	Description	Pages changed
0 – 17/09/09		

	MEMORANDUM OF UNDERSTANDING FOR THE INTERCONNECTION OF AMHS SYSTEMS		
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TABLE OF CONTENTS

	MEMORANDUM OF UNDERSTANDING FOR THE INTERCONNECTION OF AMHS SYSTEMS		
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1. Section 1 - Introduction and Purpose

1.1. Introduction

The plans for the implementation of ATN ground-ground applications and the regional ATN router plans are defined in FASID Tables CNS 1Bb and CNS 1Ba, respectively, as formulated in conclusions 13/74 - *Proposed amendment to the Regional ATN Plan* and 13/75 - *Request for information on plans to implement ATN ground-air applications.*

Document: The body of this document contains ten (10) sections and one (1) appendix. The contents of the sections and the appendix are summarised below:

a) Section 1 - Presents a brief overview and a statement of purpose;
b) Section 2 – Describes the basic principles for drafting this document;
c) Section 3 – Considers the cases in which this Memorandum applies;
d) Section 4 – Describes the version control process;
e) Section 5 – Lists the references considered;
f) Section 6 – Establishes criteria and restrictions for the use of the information shared by two countries;
g) Section 7 – Presents the operational aspects that must be considered for the interconnection of automated systems;
h) Section 8 - Presents the technical aspects that must be considered for the interconnection of automated systems;
i) Section 9 - Presents the administrative aspects that must be considered for the interconnection of automated systems;
j) Section 10 - Presents the financial aspects that must be considered for the interconnection of automated systems;
k) Section 11 – Technical-operational agreement for the interconnection of AMHS systems.

1.2. Purpose

The goal of this MoU is to provide the planning for the interconnection of AMHS systems, establishing standard procedures that take into account the operational, technical, administrative, and financial aspects involved.

	MEMORANDUM OF UNDERSTANDING FOR THE INTERCONNECTION OF AMHS SYSTEMS	
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2. Section 2 - Principles

In preparing this document, the following aspects have been considered:

1. This Memorandum is a guide for States to enter into bilateral agreements; and

2. This document takes into account the aspects contained in documents dealing with AMHS interconnection, ICAO SARPs and documents, documents prepared by project RLA 06/901, and in GREPECAS recommendations.

3. Section 3 - Scope

This document only applies to the interconnection of AMHS systems between States A and B.

4. Section – Organisation

This is a document by virtue of which the participating States will agree to revise or modify its details as necessary.

The participating States will coordinate the revisions to this Memorandum, or changes to its paragraphs.

5. Section 5 - References

This Memorandum follows the ICAO recommendations contained in the following documents:

- Report of the SAM IG/2 meeting, Lima, Peru, 3-7 November 2008;
- Report of the SAM IG/3 meeting, Lima, Peru, 20-24 April 2009;
- Report of the sixth meeting of the CNS Committee of the ATM/CNS Subgroup (CNS/COMM/6), Santo Domingo, Dominican Republic, 30 June - 4 July 2008;
- Report of the GREPECAS 15 meeting (Rio de Janeiro, Brazil, 13 to 17 October 2008);
- Fifth meeting of the ATN Task Force of the CNS Committee of the ATM/CNS Subgroup (ATN/TF/5), Mexico City, Mexico, 12-13 June 2009; and
- SAM COM/MET/09 meeting, Lima, Peru, 10–12 August 2009.

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6. Section 6 - Confidentiality

Each participating State must implement all the measures necessary to ensure the safety, integrity, and confidentiality of the information.

The dissemination of these data to other organisations not considered in this Memorandum can be done only if previously authorised by the participating States.

7. Section 7 - Operational Aspects

The application of this Memorandum may require adjustments to the operational agreements that exist between the participating States.

The Administrations undertake to provide training on the appropriate parts of this MOU to their personnel working in the systems involved.

8. Section 8 - Technical Aspects

The technical considerations for the establishment, by the States, of the interconnection scenarios, the implementation strategy, the implementation of the solution, the monitoring of the operation, and personnel training aspects that will best meet their needs are presented in Section 6 of the Appendix to this Memorandum.

9. Section 9 - Administrative Aspects

For the orderly implementation of the selected interconnection solution, the participating States agree to the creation of an administrative structure based on an Interconnection Management Committee, whose powers, composition, and activities are described in Section 7 of the Appendix to this Memorandum.

The States must designate representatives, members of their respective groups, to be part of the basic structure of the aforementioned Committee.

The States must choose a forum for discussing cases of non-compliance and for the resolution of possible conflicts.

This Memorandum is of a continuous nature, and may be interrupted at any time, by agreement of the parties involved.

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10. Section 10 - Financial Aspects

The participating States, as individual administrations, will be responsible for any financial obligation to cover direct or indirect expenditures related to the implementation of this Memorandum, including those related to the procurement of equipment, spare parts, training of technical and operational personnel, lines of communications, and others.

Each State will be responsible for its respective portion of any expenses related to REDDIG upgrades to address increased traffic, in keeping with guidance provided by the REDDIG Administration.

The parties to this Memorandum understand that they shall not commit to any action that may result in a financial obligation for other parties without previously obtaining the written consent by all the other parties involved.

The States may establish financial mechanisms to carry out the interconnection, for example, through ICAO Technical Cooperation Projects.

11. Section 11 – Technical-Operational Agreement for the Interconnection of AMHS Systems

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APPENDIX A

MEMORANDUM OF UNDERSTANDING

TECHNICAL-OPERATIONAL AGREEMENT FOR THE INTERCONNECTION OF AMHS SYSTEMS

TABLE OF CONTENTS

	MEMORANDUM OF UNDERSTANDING FOR THE INTERCONNECTION OF AMHS SYSTEMS		
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1. Purpose

To provide a detailed description of the technical, operational, and administrative aspects of the Memorandum of Understanding that are needed for the interconnection of AMHS systems between States A and B.

2. Summary

- The plans for the implementation of the ATN ground-ground application and the plans for regional ATN routers, as defined in FASID Tables CNS 1Bb and CNS 1Ba, respectively, were formulated through conclusions 13/74 - *Proposed amendment to the Regional ATN Plan* and 13/75 - *Request of information on plans for the implementation of ATN ground-air applications* and reviewed at the sixth meeting of the CNS Committee of the GREPECAS ATM/CNS Subgroup (ATM/CNS/SG/6). Tables CNS1Ba and CNS1Bb were reviewed at the ATN/TF/5 meeting, held in Mexico, on 12-13 June 2009.
- The regional AMHS addressing plan that the States should apply when implementing AMHS systems in the SAM Region was presented at the GREPECAS 15 meeting (Appendix M to agenda item 3) and reviewed by the COM/MET/09 meeting held in Lima, Peru, on 10-12 August 2009.
- The States that have implemented or are planning to implement AMHS systems should register before the ATS message transmission management centre (AMC), according to ICAO State letter AN 7/49.1-09/34 of 14 April 2009 on management and updating of information on addresses of the air traffic service (ATS) message handling system (AMHS), and the procedure for registering a State representative as user of the AMC.

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- The ATN/TF/5 meeting reviewed the IPv4 addressing scheme and, in this respect, considered that, at the national level, the States, when implementing AMHS systems based on IP, could adopt the Ipv4 addressing scheme. The meeting also considered that, for intra-regional links between AMHS systems, the Ipv4 addressing scheme shall be used, and, accordingly, formulated conclusion 5/1 - *Proposed Ipv4 addressing scheme for ATN ground-ground applications at the intra-regional level*.
- For the interconnection of the AMHS systems installed in the Region, consideration has been given to conducting trials between MTAs to check the interoperability of AMHS systems, and a study of the bandwidth required for their interconnection.

3. Reference

This Agreement follows the recommendations contained in the following documents:

- Report of the SAM IG/2 meeting, Lima, Peru, 3-7 November 2008;
- Report of the SAM IG/3 meeting, Lima, Peru, 20-24 April 2009;
- Report of the sixth meeting of the CNS Committee of the ATM/CNS Subgroup (CNS/COMM/6), Santo Domingo, Dominican Republic, 30 June - 4 July 2008;
- Report of the GREPECAS 15 meeting (Río de Janeiro, Brazil, 13-17 October 2008).
- Fifth meeting of the ATN Task Force of the CNS Committee of the ATM/CNS Subgroup (ATN/TF/5), Mexico City, Mexico, 12-13 June 2009; and
- SAM COM/MET/09 meeting, Lima, Peru, 10–12 August 2009.

4. Safety

Each State must ensure that its communication networks involved in the interconnection have the required protection for this type of service, taking into account, at least, the following aspects:

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- Protection against intrusion by unauthorised people and/or systems;
- Protection against attacks from computer viruses; and
- Use of the equipment exclusively for the interconnection of automated systems.

5. Operational Aspects

The Administrations undertake, within their respective jurisdiction, to provide direct training on the contents of this Memorandum of Understanding to the personnel working in the systems involved.

The selected interconnection option entails that States will have to establish specific operational procedures, taking into account the functionality available in each automated system.

6. Technical Aspects

The interconnection must permit the automatic transfer of messaging plans between the two States, using the respective MTAs;

The main aspects are:

1) Analysis of the current scenario: Currently, both States have completed the deployment of their AMHS systems at the national level, but the operating mode between the two is still AFTN, that is, using the gateway, as shown in the following graphical example:

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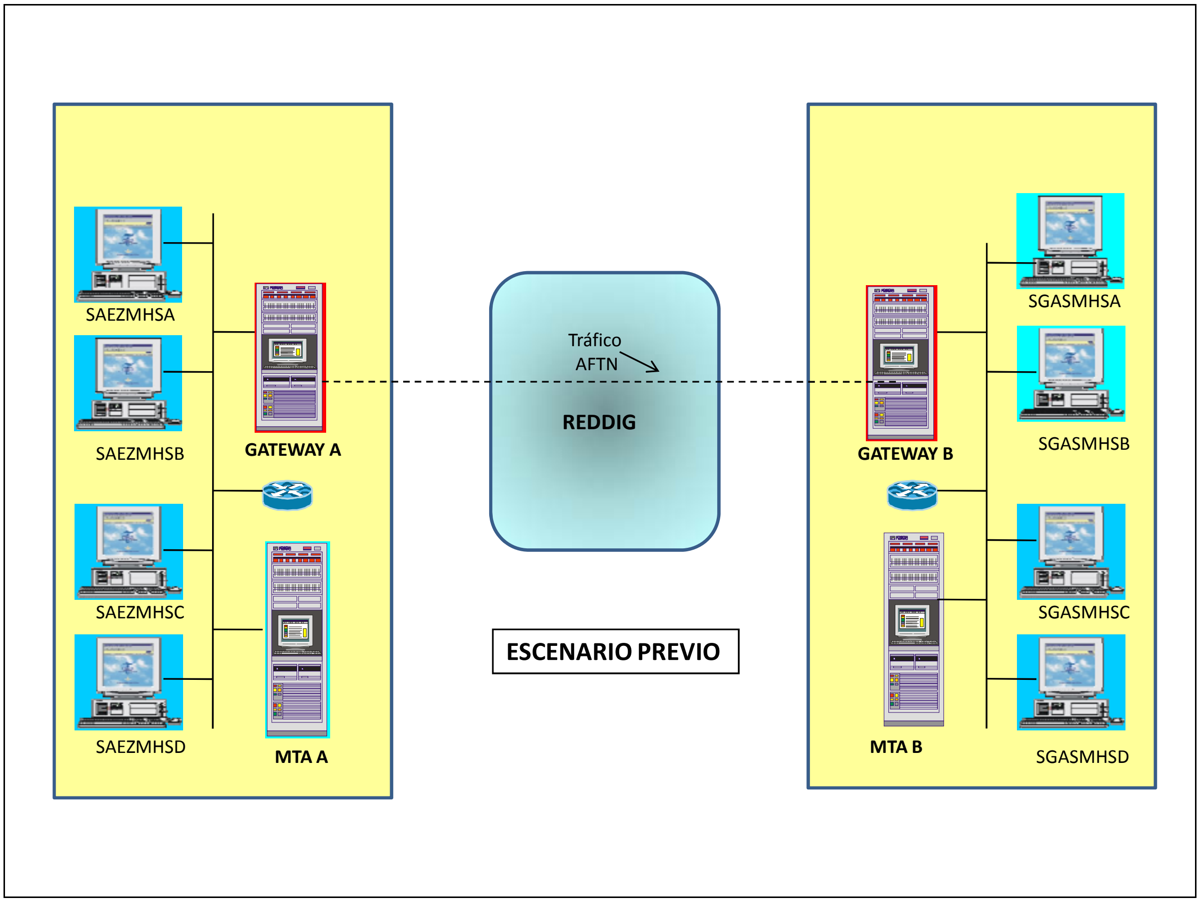

2) Selection of the exchange scenario: the functional scenario can only be as follows, in which the exchange of traffic between States is already being carried out through the interconnection of the respective MTAs, leaving the gateway operational for the exchange of messages with those States that have not migrated to the AMHS:

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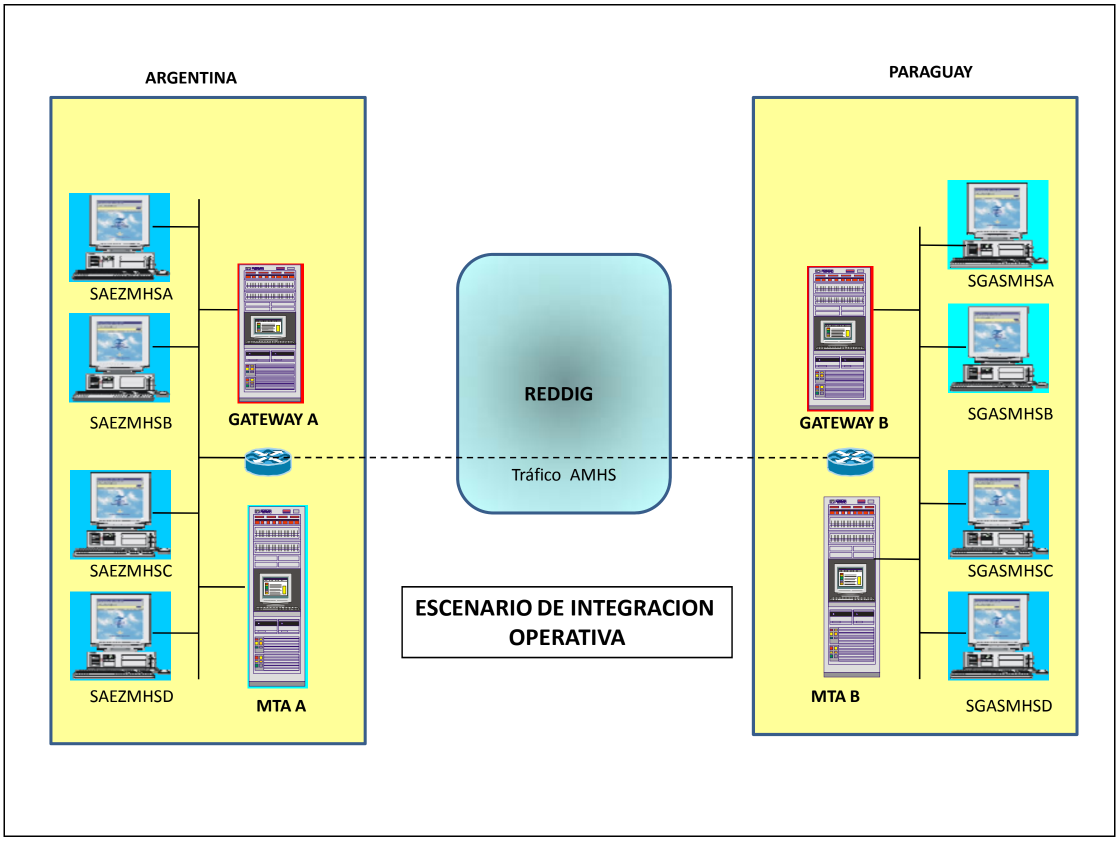

3) <u>Implementation Strategy</u>:

In order to achieve the desired objective, the following action must be taken, indicating, in each case, whether such action has already taken or the tentative date for its implementation:

- Data transportation network: Intra-regional IP ATN
- Means: REDDIG
- Channel: DLCI
- ATN boundary elements: routers provided by each State
- IP addressing of router link ports: to be configured according to the Regional IP Addressing Plan, Link Ports
- Serial interfaces: V.35

- Tests:
  - *Network transport*: by REDDIG administrator
  - *Network connectivity*: by *State A* and *State B*
  - *Message exchange*:
  - *Exchange of technicians between States*:
  - *Preparatory phase*:
- *Operational status*:

4) <u>Implementation:</u>

- The Interconnection Management Committee will be in charge of implementation management, and will be made up by personnel listed in Attachment A.
- This Interconnection Committee will perform its functions until three (3) months after the beginning of the Operational Phase; thereon, the integrated operation will be entrusted to the respective Communication Stations.

5) Operation Monitoring

Each State must be responsible for monitoring the operation of its systems, including the maintenance of its equipment and systems, ensuring the required availability, performance, safety, and efficiency.

All problems of uncertain origin must be analysed jointly by the States through the Interconnection Management Committee, which will coordinate the actions required for their resolution.

However, each State must do its best to carry out the actions under its responsibility, informing the Interconnection Management Committee about their implementation.

In any case, the Interconnection Management Committee must be constantly informed about the occurrence of anomalies, regardless of their origin.

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6) Training

The participating States must develop training plans for the technical teams responsible for system maintenance, taking into account extent, periodicity, and technical evolution.

7) Maintenance

Teams must be prepared for contingencies and be technically capable of analysing anomalies.

Each State shall develop its own Action Plan, which will define the technical information required for the interconnection with adjacent ACCs, and will contain, at least:

1. The topology of the networks involved, with technical details about the bandwidth, availability, latency, and redundancy required;
2. The specifications of the equipment used;
3. Maintenance requirements;
4. Maintenance procedures: preventive, predictive, and corrective; and
5. All related technical documents;
7. The States agree that the means of communication for the implementation of the interconnection will be the REDDIG.

7. Administrative Aspects

This Agreement is a dynamic document that can be revised at any time, in keeping with the technological evolution of the systems and communication networks of the participating States.

Interconnection management will be entirely the responsibility of the Interconnection Management Committee established by the two (2) States, in accordance with the following:

1. Organisational Structure

In order to carry out its activities, the Committee will be organised as follows:

1. Coordinator

The coordinators for AMHS interconnection between States A and B are listed in **Annex A.**

Coordinators will be responsible for general coordination of all the activities of the technical and operational groups, and for maintaining contact with other organisations to address interconnection issues.

2. Technical Group

It must include technicians designated by the two States, with training in their respective fields, especially in communication networks and computer automation systems.

They will be responsible, in their respective country, for the implementation and/or coordination of the technical activities required for the implementation, maintenance, and support of automated systems, communication networks, and interconnection equipment.

3. Operational Group

It must include experts in the operation of electronic messaging systems.

2. Functions

The Committee is responsible for all the coordination required for the planning, implementation, maintenance, and operational support of the systems and equipment involved in the interconnection of AMHS systems.

It must also ensure the continued safety of the information to be transmitted between the automated systems involved in the interconnection.

Its functions include controlling and updating all technical and operational documentation.

It is also responsible for the network topology to be used for the interconnection, which must be approved by the two (2) States.

Interconnection implementation must be coordinated and controlled by the Committee, through action plans previously approved by the two (2) States.

The Committee must advise the States about the need for technological evolution of the equipment and systems involved in the interconnection.

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Its teams must monitor the performance, stability, reliability, and integrity of the equipment and systems involved in the interconnection, and propose and monitor corrective action.

The Committee must establish the necessary procedures for correcting faults.

Also, together with the participating States, it must provide for the resolution of problems.

3. Management Process

In order to carry out its activities, the Interconnection Management Committee will apply the following management system:

1. Periodic meetings and discussions to identify requirements, preferred technical solutions, alternatives, and options for the interconnection of AMHS systems;
2. Exchange of technical reports and documentation, plans and schedules as required for a successful and timely culmination of these efforts.
3. Joint planning, technical coordination, and implementation of activities by the two (2) States.

8. Financial Aspects

Regarding financial aspects, the States agree to the following:

1. Acquisition of equipment, components, and systems;

   The equipment necessary for the interconnection will be acquired by each State, according to the technical specifications approved by the Interconnection Management Committee;

2. Acquisition of spare parts

   Spare parts for the equipment involved in the interconnection will be purchased by each State, according to its specific needs, but in keeping with the maintenance guidelines issued by the Interconnection Management Committee.

3. Acquisition of third-party services

Each State agrees to pay for incidental third-party services, such as software adjustments, projects, and implementation of communication networks.

Each State will be responsible for its share of the incidental cost of upgrades to the REDDIG to address traffic increases, in keeping with the guidance issued by the REDDIG Administration.

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ANNEX A

AMHS SYSTEM INTERCONNECTION MANAGEMENT COMMITTEE

COORDINATORS OF THE MANAGEMENT GROUP

State A

Name:
Phone number:
Email:

State B

Name:
Phone number:
Email:

APPENDIX C / APENDICE C

ACTION PLAN FOR AMHS INTERCONNECTION / PLAN DE ACCION PARA LA INTERCONEXION DE LOS SISTEMAS AMHS

States/Estados	Network Transport/ Transporte Red	Connectivity/ Conectividad	Message Exchange Trials/ Pruebas de Intercambio Mensajes	Operational Integration/ Integracion Operativa
1	**2**	**3**	**4**	**5**
Argentina-Chile	Carried out/ Realizado	04 Jan 2010	Mar 2010	Apr 2010
Argentina-Perú	Carried out/ Realizado	Carried out/ Realizado	Dec 2009	To be defined/ A definir
Argentina- Paraguay	Carried out/ Realizado	Carried out/ Realizado	Realizado	Established in respective MoU/ Establecido en MoU respectivo
Argentina- Brasil	Carried out/ Realizado	Carried out/ Realizado	Established in respective MoU/ Establecido en MoU respectivo	Established in respective MoU/ Establecido en MoU respectivo
Brasil-Paraguay	Carried out/ Realizado	Mar 2010	Established in respective MoU/ Establecido en MoU respectivo	Established in respective MoU/ Establecido en MoU respectivo
Brasil-Colombia	Carried out/ Realizado	May 2010	May 2010	To be defined/ A definir
Brasil-Perú	Carried out/ Realizado	Jul 2010	Jul 2010	To be defined/ A definir
Colombia-Perú	Carried out/ Realizado	09 Nov 2009	09 Nov 2009	To be defined/ A definir
Chile-Perú	Carried out/ Realizado	16 Nov 2009	16 Nov 2009	To be defined/ A definir

APPENDIX D

ADS-B TRIALS IN THE SAM REGION

Trial objectives

1.1 The main objectives of the trial were as follows:

a) Obtain technical experience on the installation and configuration of an ADS-B ground station and TSD terminal;
b) Collect radar data; and
c) Analyse and process the collected ADS-B data.

Considerations prior to the installation of the equipment

1.2 The TSD terminal and the ADS-B ground station were installed at the premises of the air navigation service provider of Peru, CORPAC, at the radar building, in the briefing room and in the FDP radar equipment room (next to the Lima ACC Control Centre). This location was considered appropriate, given its easy access for local ATC personnel and CNS technical personnel and visitors, the availability of local connectivity (LAN), 220 VAC power with UPS, pole for the ADS-B/GPS antenna, and security. It should be noted that the control tower building of the Jorge Chávez Airport is an obstacle for this location.

Technical description of the equipment used for trials

1.3 The make of the ADS-B equipment installed was Thales, AS-68X family, AS680 series, consisting of:

a) ADS-B receiving antenna;
b) GPS antenna;
c) Antenna amplifier unit;
d) Signal processing unit (AS 680 SPU);
e) Remote control and monitoring system (RCMS) of the ADS-B earth station;
f) Local control and monitoring system (LCMS); and
g) Technical Situation Display (TSD) terminal.

2.3.1 **Appendix A** illustrates the equipment used in the ADS-B trials, and contains an extract of the equipment data sheet.

Activities carried out during the trial

2.4 The activities carried out during the trials were the following:

a) Installation of the ADS-B ground station and antennas (ADS-B and GPS);
b) Installation of the TSD terminal;
c) Operational tests;
d) Practical training of CORPAC CNS and ATM personnel on the operation of the station;
e) Development of a format for recording data;
f) Data collection;

g) Data analysis; and
h) Presentation of results at the CORPAC seminar.

Coverage of the ADS-B trial

2.5 **Appendix B** illustrates the theoretical coverage (line of sight) of the station located in Lima, and the targets of both the radar system and the ADS-B ground station installed at the Jorge Chávez International Airport.

2.6 The coverage obtained during the ADS-B trials was:

a) To the North-West: up to 260 nautical miles;
b) To the North: up to 250 nautical miles;
c) To the South: up to 240 nautical miles;
d) To the South-East: from 180 up to 200 nautical miles; and
e) To the East: up to 80 nautical miles.

Data analysis

2.7 The data provided by the TSD terminal are in ASTERIX CAT-21 format, edition 0.23 (EUROCONTROL). All of the information collected below corresponds only to aircraft operating within the coverage of both surveillance systems (ADS-B, secondary radar).

2.8 The analysis of the collected data revealed the following:

a) ***General data:*** The following table shows the total data assessed from 4 to 29 June 2009 and the daily averages.

	TOTAL	DAILY AVERAGE
Flights detected by RADAR	7956	306
Flights of aircraft equipped with extended Mode S	3925	151
Aircraft detected by ADS-B	1397	54

b) ***Comparison of data on speed and level:*** Based on data collected on 11-29 May of this year, information on speed and level of the selected aircraft, provided by both surveillance systems (radar and ADS-B), at specific times or positions, was recorded and compared. The final averages of these data are summarised below:

AVERAGE OF DIFFERENCES BETWEEN THE TWO SURVEILLANCE SYSTEMS	
of recorded speeds (GS)	+/- 13 knots
of flight levels, between modes C and S	+/- (221 feet)

In the case of the average of recorded speeds, comparisons were not always possible because Mode S sometimes transmitted the true airspeed (TAS); speed fluctuations were between 1 and 40 knots.

The differences in the results of recorded flight level averages were in some cases nil. However, on other occasions, differences of 100 to 200 feet were recorded. The most outstanding case was that of an aircraft that showed a difference of 510.25 ft, which we assume to be the result of a series of errors (altimetry, transponder, rate of climb or descent, information update time), *inter alia.*

c) ***Identification errors:*** The most frequent aircraft identification errors found between 4 and 29 June 2009 are shown below:

DESCRIPTION	QUANTITY	%
Number of flights with identification errors	597	15
Number of flights with an ID spontaneously changed by the software (apparent avionics – B744)	16	0.41
Number of flights with correct ID	3328	85
Number of flights analysed	3925	100

Of the 3,925 aircraft (with extended Mode S) analysed, 597 (15%) had flight identification errors.

It was noted that identification errors can be caused by an incorrect entry of, or failure to enter, the flight identification by the crew, an equipment or software error, as occurs with some B744s, which spontaneously transmit a “U” at the end of the assigned field. This letter appears only for a few seconds (9 to 10 seconds in most cases). However, especially in the case of errors generated by the crew, these problems can be corrected by providing proper training and information on this issue to the operators.

A particular case occurred on 5 June: an aircraft (IL96) overflying at FL350, with the correct flight identification but with the 24-bit address (assigned by ICAO), with characters that did not belong to that field (9.00E+66). According to the data collected, no other case of error in the 24-bit address field was recorded.

d) ***NUCp values obtained:*** Regarding the NUC analysis (4-29 June), and taking into account a theoretical acceptable value of NUC>4, the following was obtained:

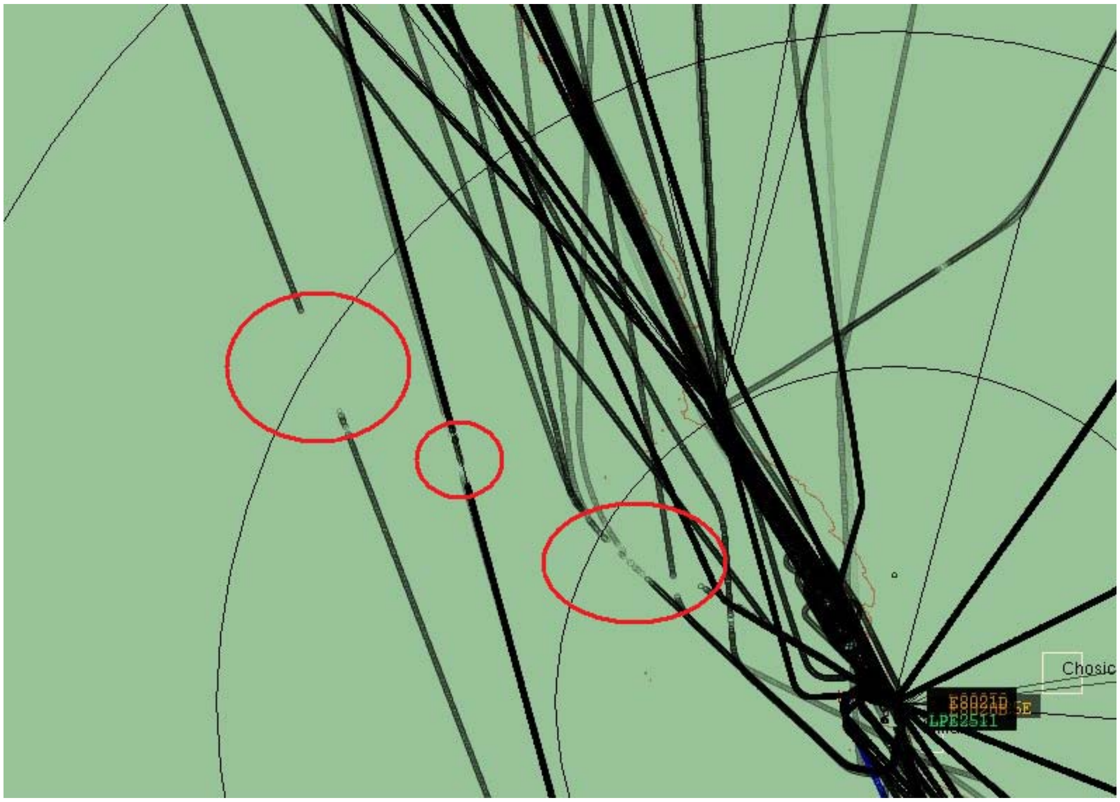
NAVIGATIONAL UNCERTAINTY CATEGORY FOR POSITION (NUCP) DO-260A							
TOTAL NUMBER OF FLIGHTS WITH							
FOM/PA (0)	FOM/PA (2)	FOM/PA (3)	FOM/PA (4)	FOM/PA (5)	FOM/PA (6)	FOM/PA (7)	FOM/PA (8)
1297	25	18	37	183	2769	2681	1
1377				**5634**			

Some data transmission losses were recorded (excluding those caused by obstacles), which deserve a more in-depth investigation in order to assess the RAIM.

e) ***Percentage of flights with ADS*-B response:** In the trials of 4 to 29 June 2009, note was taken that 18% of aircraft has extended squitter Mode S. In average, these aircraft conduct 50% of daily flights.

	DAILY AVERAGE PERCENTAGE
Aircraft with extended Mode S	18%
Flights conducted with extended Mode S	50%

f) ***Shadowing due to location***: Shadowing caused by the control tower building on aircraft in some parts of the movement area and to the North-West (approximately 300 radial of LIM) of the Jorge Chávez airport was confirmed during the tests.



2.9 **Conclusions**

a) First-hand knowledge has been acquired on the operation of the ADS-B surveillance system based on the extended Mode S;

b) The difference and level of detail were derived from comparing the data provided by the ADS-B and radar surveillance systems;

c) The large number of flights reported with extended Mode S points to the need for gradual implementation of standards, procedures and equipment for future operational use of ADS-B;

d) Some problems have been identified, such as incorrect aircraft identification values, that warrant a subsequent analysis in future trials; and

e) At present, the Peruvian State continues assessing the ADS-B station. It is also considered important to continue carrying out this type of trials in the Region and to share the experience.

3. **Suggested action**

3.1 The meeting is invited to consider the information contained in this paper and to review its **Attachments A** and **B**, so that they can serve as a reference for any State wishing to conduct ADS-B trials.

ATTACHMENT A

TECHNICAL SPECIFICATIONS OF ADS-B EQUIPMENT

Received RF signals are converted into video signals by the RXU's logarithmic receiver, and analyzed by the Signal Processing Board in order to reliably detect ADS–B signals. The decoded data are collected and further processed by the application software of the SBC. The optional GPS Timing System provides a positive system time reference to support the SBC's real time clock. It also provides additional information about GPS status, like position, dilution of precision, number and identity of satellites visible and – optionally – also GPS integrity information in the same way as an ADS–B target (RAIM / HPL). The ground station constantly verifies GPS health by checking the deviation of the measured GPS position versus the configured ground station position.

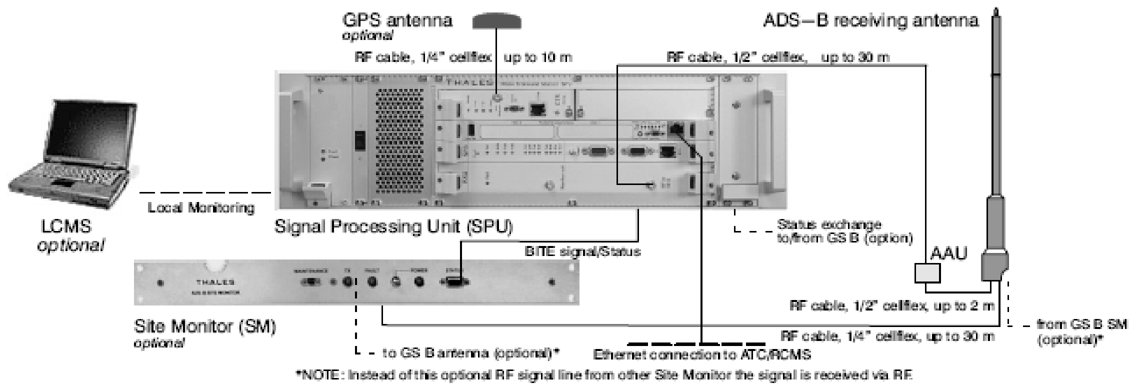


Fig. 1–5 ADS–B serviceable ground station equipment (exemplary view)

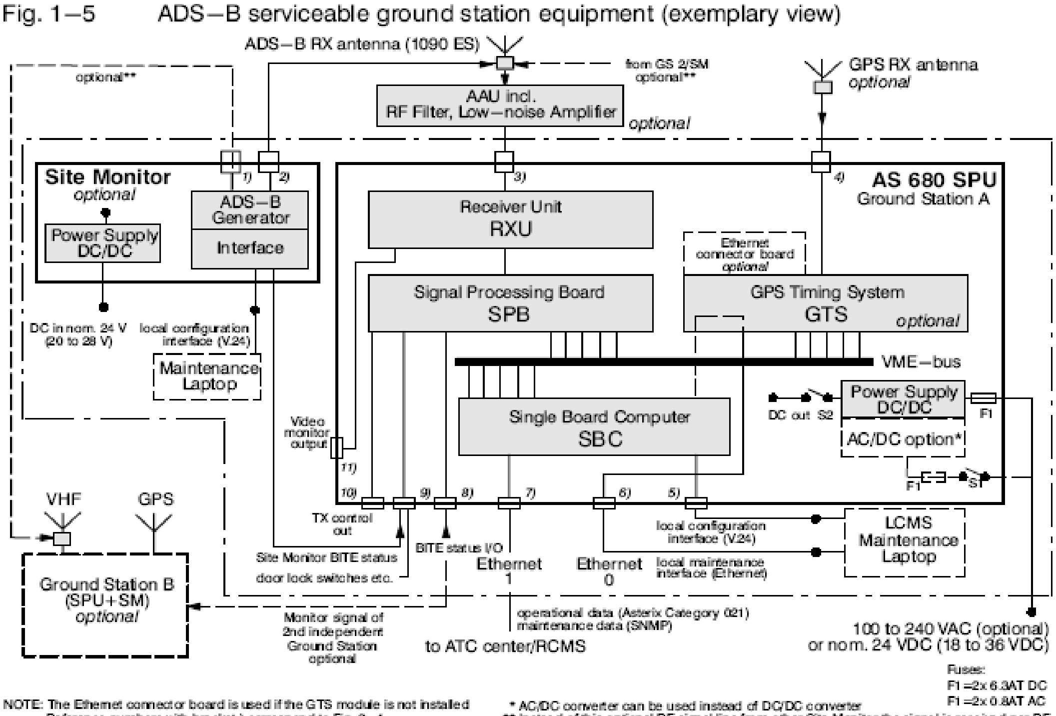


Fig. 1–6 ADS–B serviceable ground station architecture, exemplary configuration

1.5 TECHNICAL CHARACTERISTICS

1.5.1 Dimensions and Weight

AS 680 basic system:		
− AS 680 SPU equipped; HxWxD; weight		19", 3HU; 133x482x250 mm; approx. 7.1 kg
Site Monitor (SM) option; HxWxD; weight		19", 1HU; 43x482x250 mm; approx. 1.0 kg
Configured system versions (optional):		
AS 681 with cabinet, equipped; HxWxD; weight		19", 9HU; 600x600x600 mm; approx. 90 kg
− SPU, HxWxD; weight		19", 3HU; 133x482x250 mm; approx. 7.1 kg
− SM, HxWxD; weight		19", 1HU; 43x482x250 mm; approx. 1.0 kg
− Data Switch, HxWxD; weight		19", 1HU; 43x482x180 mm; approx. 1.5 kg
− UPS, basic, HxWxD; weight		19", 2HU; 86x444x410 mm; approx. 19 kg
AS 682 with cabinet, equipped; HxWxD; weight		19", 24HU; 1200x600x600 mm; approx. 150 kg
− SPU, HxWxD; weight	(2x)	19", 3HU; 133x482x250 mm; approx. 7.1 kg
− SM, HxWxD; weight	(1x)	19", 1HU; 43x482x250 mm; approx. 1.0 kg
− Data Switch, HxWxD; weight	(1X)	19", 1HU; 43x482x180 mm; approx. 1.5 kg
− UPS, basic, HxWxD; weight	(2x)	19", 2HU; 86x444x410 mm; approx. 19 kg
− UPS, extension, HxWxD; weight	(2x)	19", 2HU; 86x444x410 mm; approx. 25 kg

1.5.2 Peripheral Equipment

ADS−B RX antenna options:	
− Omnidirect. Kathrein, 11.5 dBi, H,∅; weight	max. 3420 mm, 60 mm; approx. 26 kg max.
− Omnidirectional FAN96, 9 dBi, H,∅; weight	max. 2700 mm, 60 mm; approx. 24 kg max.
− Omnidirectional AAN186, 6 dBi, H,∅; weight	max. 1640 mm, 90 mm; approx. 10 kg max.
Antenna Amplifier Unit (AAU), HxWxD; weight	280x180x105 mm; approx. 4 kg
− AAU support and cover, HxWxD; weight	300x255x220 mm; approx. 5 kg
GPS antenna (option), (HxW); weight (2x)	60x100 mm; approx. 0.3 kg

1.5.3 Power Supply

SPU	
AC voltage input (AC/DC converter option)	100 to 240 VAC, 50/60 Hz, single phase
DC voltage input (DC/DC converter option)	nom. 24 VDC, 18 to 36 VDC, max. 4.5 A
Power consumption	approx. 55 VA
Site Monitor (option)	
AC voltage input via plug−in mains supply	100 to 240 VAC, 50/60 Hz (DC out 24 V)
Power consumption	approx. 5 VA
DC voltage input	nom. 24 VDC, 20 to 28 VDC, max. 1 A
Data Switch (option)	
AC voltage input	100 to 240 VAC, 50/60 Hz, single phase
DC intern	5 V, max. 8 A
UPS type (option)	RS 1000 with 1 battery extension
AC voltage input / max. current	160 to 276 VAC, 50 Hz, single phase / 6.0 A
AC voltage output	208/220/230/240 VAC / 50 Hz
Power rating	approx. 1000 VA (700 W)
Batteries	3x 12V, 7Ah
Battery extension	1
Typical battery time (battery mode) in [min]	53 (100 % load), 122 (50 % load)

1.5.4 Environmental Conditions

Ambient temperature	
Operation indoor (SPU, Data Switch, SM, UPS)	+10 to +40 °C
Operation outdoor equipment (antennas)	−40 to +70 °C
Transport	−55 to +70 °C
Relative humidity	
indoor	max. 90%, non condensing
outdoor	max. 95% (−10 to +39 °C); max. 50% (40 to 70 °C)
non operation and transport	up to 100 % with condensation
Max. wind velocity optional antennas	
Antenna Kathrein (11.5 dBi)	max. 130 km/h
Antenna FAN96 (9 dBi)	max. 150 km/h
Antenna AAN186 (6 dBi)	max. 180 km/h

1.5.5 System Data Ground Station AS 68x

ADS−B System	Ground station with redundant equipment, built by 2 SPU, coupled via Data Switch to ADS−B LAN
Report generation	ASTERIX CAT 21 reports
Communication interface	UP/IP, SNMP on UDP/IP, SSH, SCP on TCP/IP

1.5.5.1 Signal Processing Unit (AS 680 SPU)

Receiving signals	1090 ES ADS−B, GPS L1−band 1575.42 MHz
Coverage range	up to 150 NM at flight level > 300, omnidirectional
Capacity (GS)	> 250 targets
Report generation	ASTERIX CAT21 (ADS−B)

1.5.6 Interfaces

AS 680 SPU	
− PC connector */**	Serial, SubD, 9 pin, male
− Data interface connector */**	RJ45, Ethernet 10/100Base−T Serial, V.24, MicroSubD, 9 pin, female
− Others */**	Serial, RS232, SubD, 9pin, female BITE, RJ45, 8pin; Status Interface I/O, SubD, 15pin, female
Site monitor	
− Communication/control */**	Serial, RS232, MicroSubD, 9pin, female;
− Status */**	Status Interface I/O, SubD, 15pin, female
− Data interface connector (ADS−B LAN) */**	2x RJ45, dual port Ethernet, 1000Base−T
Data Switch (ADS−B LAN) */**	2x 8 connectors RJ45, Ethernet, 1000Base−T

* according IEC60950 ** SELV−circuit (Safety Extra Low Voltage)

1.5.7 Conformity and Licensing Approval

The AS 680 ground station SPU is compliant to ICAO Annex 10 and to current European Regulations for human health (low voltage directive) and electromagnetic compatibility (EMC). It complies with the requirements of EC Guideline 89/336/EEC in its implementation. It also fulfills the requirements of the following EMC Guidelines:

− Emission Test: EN 55022 (1998); EN 61000−3−2 (1995); EN 61000−3−3 (1995)
− Immunity Tests: EN 55024 (1998); (EN 61000−4−2 (1995); EN 61000−4−11 (1994))

ADS-B antenna

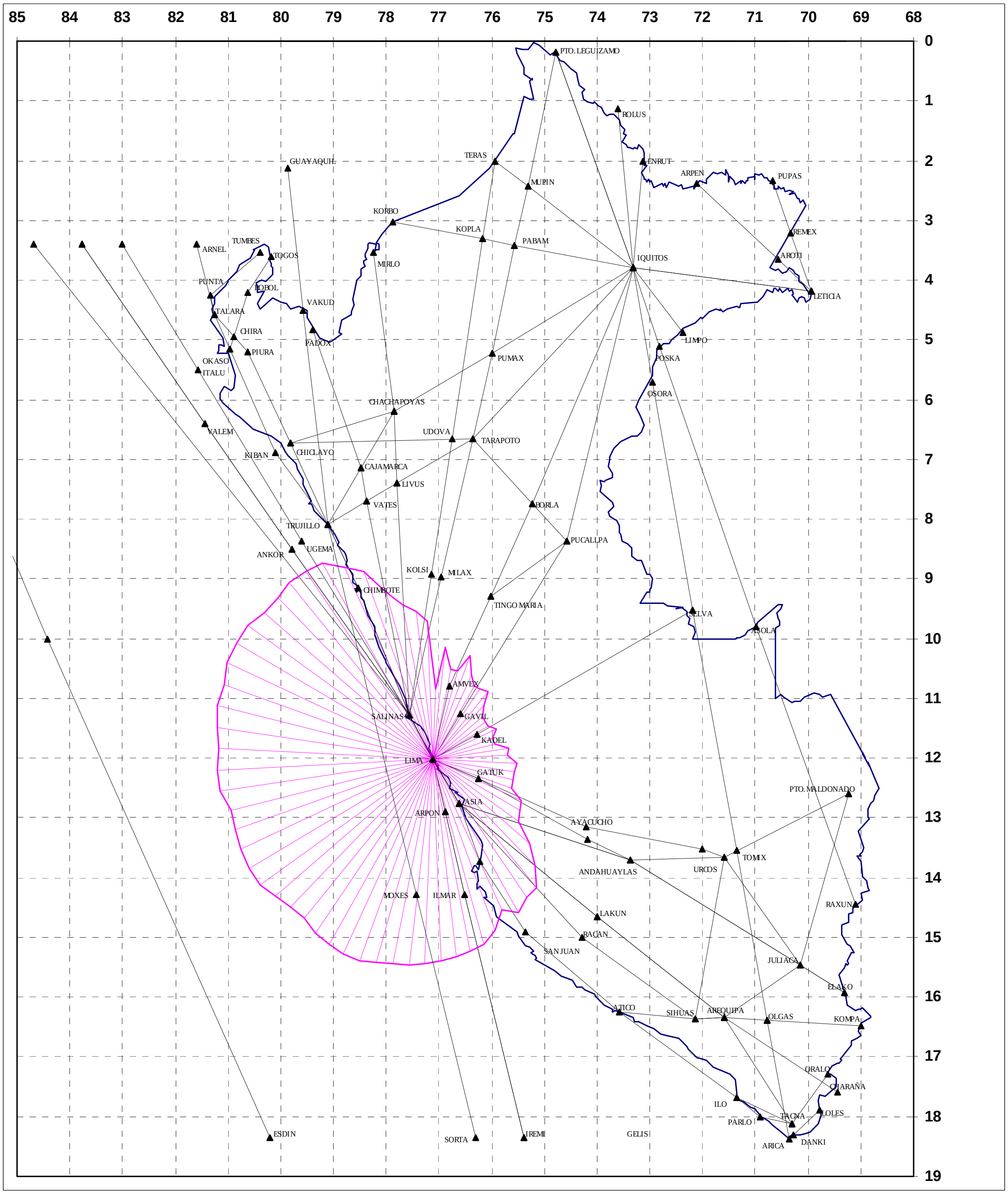
Panorámica del mástil y Antena ADS-B

ADS-B ground station

TSD
(Technical Situation Display)
terminal

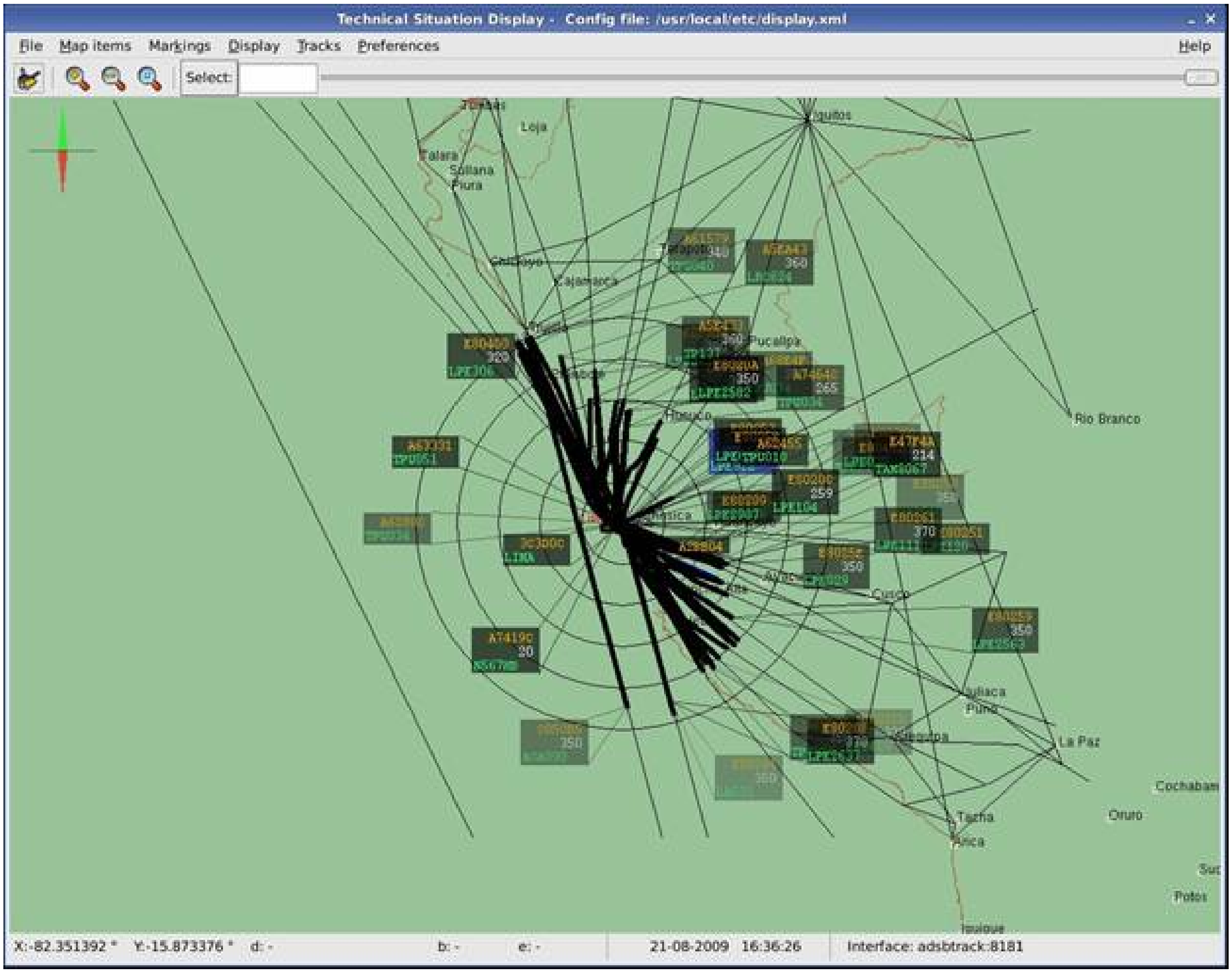
View from the ADS-B antenna
North of the Jorge Chávez airport

THEORETICAL COVERAGE OF THE JORGE CHAVEZ AIRPORT - LIMA

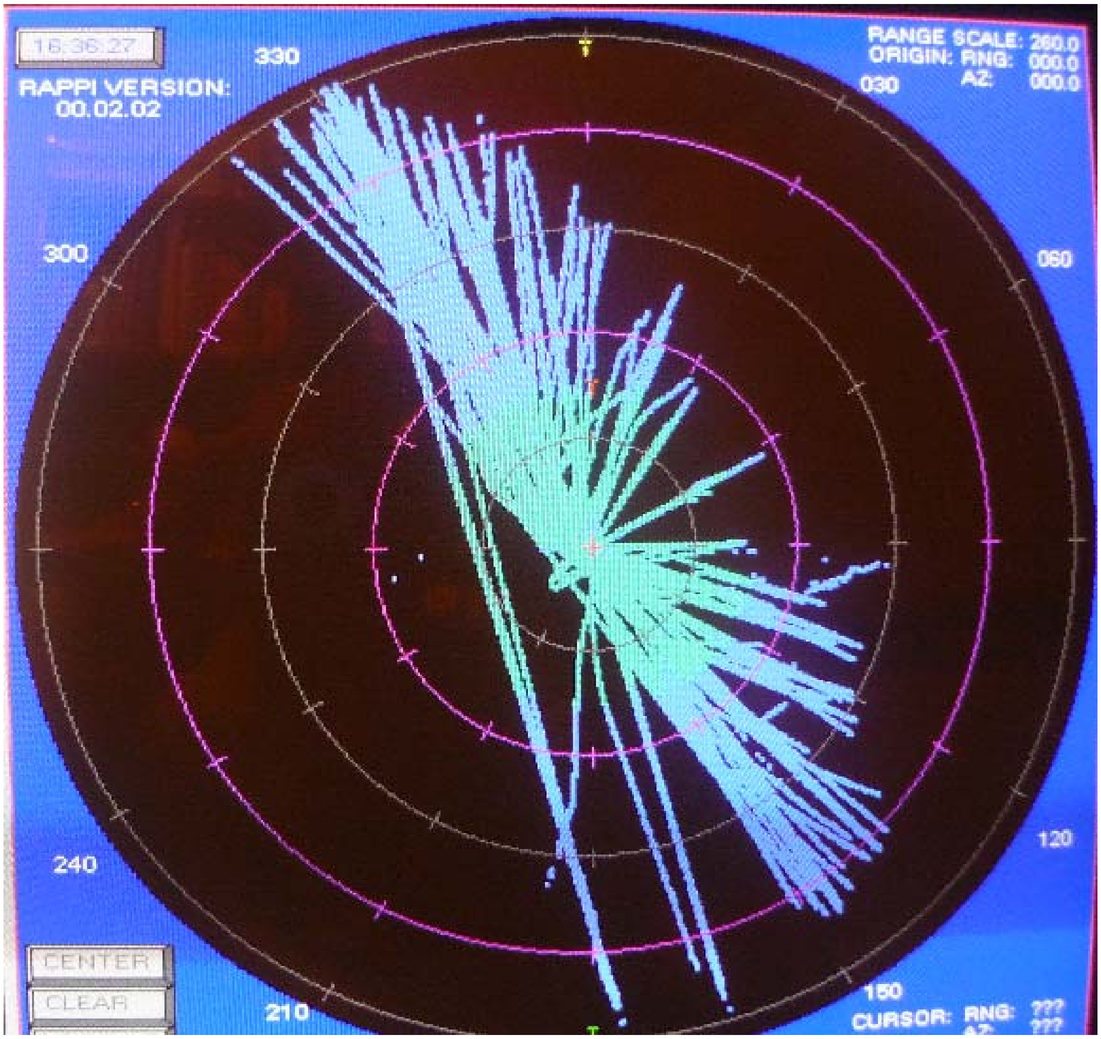


ATTACHMENT B

COVERAGE OBTAINED FROM THE ADS-B SYSTEM



COVERAGE OBTAINED FROM THE RADAR SYSTEM
(RAW DATA)



Agenda Item 7: Operational implementation of new ATM automated systems and integration of the existing systems

Interconnection of automated systems

7.1 The Meeting took note that Argentina, Brazil and Uruguay, in follow-up to Conclusion SAM/IG/3-8 - *Preparation of specific implementation plans for the interconnection of automated systems*, had drafted Memoranda of Understanding (MoU) for the interconnection of automated systems between Argentina-Uruguay, Argentina-Brazil and Brazil-Uruguay.

7.2 The afore referred MoU were prepared and signed during the ATM/CNS Argentina, Bolivia, Brazil, Paraguay and Uruguay Multilateral Meeting, held in Lima, Peru, from 14 to 18 September 2009.

7.3 These MoU contain, among other aspects, the name of the persons in charge of coordinating the interconnection, as well as estimated installation and operation dates for the interconnection of automated systems.

7.4 The Meeting considered that the MoUs between Argentina-Brazil, Argentina-Uruguay and Brazil-Uruguay were a great step towards the interconnection of automated systems in the SAM Region, and urged States involved to comply with the dates indicated in same.

7.5 The Meeting examined the action plan for the interconnection of automated systems, reviewed during SAM/IG/3 meeting. The revised plan is shown in **Appendix A** to this part of the Report. The Meeting took note that Paraguay and Peru will soon count with automated systems. Therefore, the Meeting proceeded to amend the action plan for the interconnection of automated systems with the exchange requirements of these new automated centres. Also, the plan was amended as regards the activities related with the implementation of RADNET and the exchange of surveillance data through SISTRASAG. For SISTRASAG, an analysis from Brazil is necessary, as regards its usability. For RADNET, a thorough analysis is required as to the viability for its implementation.

7.6 The Meeting, with the aim of aiding States involved in the interconnection of automated systems, adjusted the model MoU presented at SAM/IG/3 so that States, upon preparing the MoU, only fill in the information highlighted therein, related with that interconnection. **Appendix B** to this Agenda Item presents a copy of the MoU.

7.7 The Meeting took note that implementation of automated systems was planned in the short term in the Guyana, Paraguay, Peru and Suriname ACCs. In this respect, observation was made that in the SAM Region the only State with no knowledge on the implementation of automated systems in its ACC was Bolivia, therefore, it was urged to start drafting an automated systems implementation plan for its ACC.

Updating of SCID document

7.8 In follow-up to Conclusion SAM/IG/3-7 - *Updating of SCID Document* (system control interface document), the Meeting took note that many SAM States had revised said document, sending to the ICAO SAM Regional Office the corresponding changes. In this respect, the Meeting considered that this document should be kept updated and that, therefore, States should present at each SAM/IG meeting the changes to same, if any.

Course on interconnection of automated systems

7.9 The Meeting considered it necessary, in view of the interconnection of automated systems in the short and medium term in the Region, to carry out a course to support States in the interconnection of automated systems, specifically oriented towards the considerations necessary for the exchange of radar data (ASTERIX) and flight plans (OLDI, AIDC).

7.10 The Meeting agreed that the course should have, in principle, 15-day duration. In this regard, the Secretariat, together with the automation expert, would prepare a tentative programme on the contents of the course and would distribute it to States for its review by **30 November 2009**. The Meeting agreed that Regional Project RLA/06/901 approve granting a fellowship per each State member of same.

Procedures for the exchange of radar data

7.11 The Meeting analyzed a methodology proposal for the carrying out of procedures for the exchange of radar data between the automated systems in the SAM Region. In this respect, the usefulness of the document was agreed upon, having made a revision for its inclusion in ICAO Doc. 8071. In addition to the information contained in that document, **Appendix C** to this part of the Report.presents a document with further information in this regard.

Implementation strategy of Amendment 1 to the PANS ATM

7.12 The Meeting analyzed and found appropriate the strategy document for the implementation of Amendment 1 to the 15th Edition to ICAO PANS ATM (Doc. 4444) in the SAM Region (changes in the flight plan form and in the ATS messages), shown in **Appendix D** to this part of the Report.

7.13 The Meeting urged the States of the Region to start drafting their respective action plans for the implementation of the Amendment, following the actions indicated in the strategy document. The Meeting considered that the action plans should be presented at SAM/IG/5 Meeting. In this respect, the following Conclusion was formulated:

Conclusion SAM/IG/4-11 - Action plan for the implementation of Amendment 1 to Doc. 4444

That SAM States, taking into account the actions indicated in the strategy document for the implementation of Amendment 1 to ICAO PANS ATM, 15th Edition (Doc. 4444), contained in Appendix D to this part of the Report, draft their respective action plans for the implementation of the amendment, and send them to the ICAO SAM Regional Office by **30 March 2010**, for their presentation at SAM/IG/5 Meeting.

Impact of PBN implementation in automated systems

7.14 With respect to the impact that PBN implementation could have on the SAM Region, both in the ATM automated systems as in the communications systems, the Meeting deemed necessary to carry out a more thorough analysis as to what these changes would represent, on the basis of the airspace scenarios in the short term PBN implementation action plans, both for en route operations as for TMA, presented in SAM/IG/2 meeting. In this respect, the Meeting considered important obtaining information from States having automated systems, as to the impact that PBN implementation would have on the automated systems. The aeronautical administrations were suggested to make their respective consultations to their automated systems providers. In this regard, the Meeting formulated the following Conclusion:

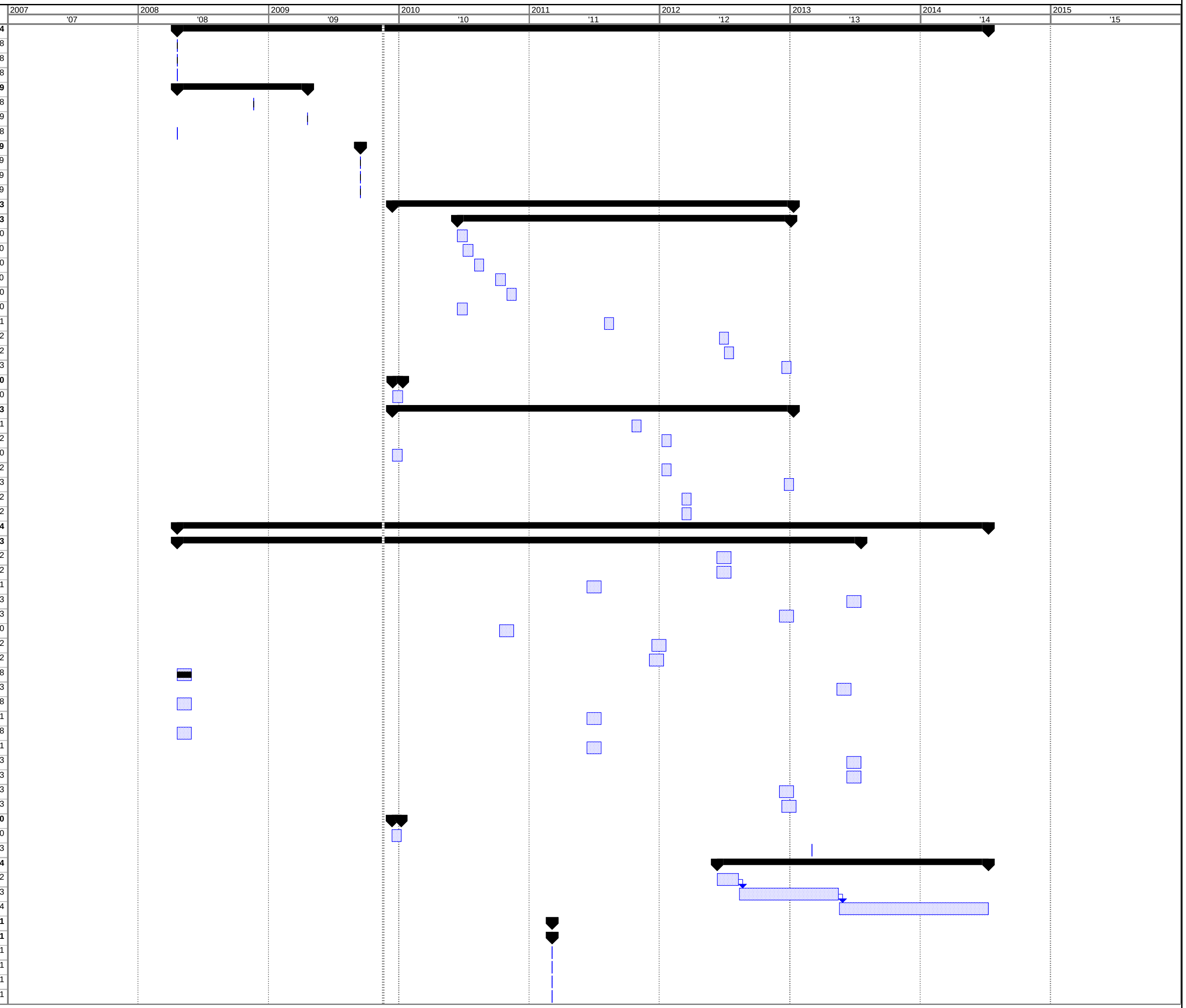
Conclusion SAM/IG/4-12 - Analysis of the impact of PBN implementation in automated systems

That SAM States carry out an analysis on the impact of PBN implementation in the short term in their automated systems, and inform of the results to the ICAO SAM Regional Office no later than **18 December 2009**.

Appendix A to the Report on Agenda Item 7 / Apéndice A al Informe sobre la Cuestión 7 del Orden del Día

APPENDIX A / APENDICE A

ID	Nome da tarefa	Duration	Start	Finish
1	**Plan de Interconexión Región SAM**	**1625 days?**	**Mon 4/21/08**	**Fri 7/11/14**
2	Aprobación del Plan	1 day?	Mon 4/21/08	Mon 4/21/08
3	Creación de la Equipo de Gestión	1 day?	Mon 4/21/08	Mon 4/21/08
4	Ejecución	1 day?	Mon 4/21/08	Mon 4/21/08
5	**Reuniones de coordinación**	**262 days?**	**Mon 4/21/08**	**Tue 4/21/09**
6	SAM/IG/2	1 day?	Fri 11/21/08	Fri 11/21/08
7	SAM/IG/3	1 day?	Tue 4/21/09	Tue 4/21/09
8	SAM/IG/4	1 day?	Mon 4/21/08	Mon 4/21/08
9	**Establecimiento de MoU**	**1 day?**	**Wed 9/16/09**	**Wed 9/16/09**
10	Argentina - Uruguay	1 day?	Wed 9/16/09	Wed 9/16/09
11	Argentina - Brasil	1 day?	Wed 9/16/09	Wed 9/16/09
12	Brasil - Uruguay	1 day?	Wed 9/16/09	Wed 9/16/09
13	**Interconexión de Plan de Vuelo**	**804 days**	**Tue 12/15/09**	**Fri 1/11/13**
14	**OLDI**	**669 days**	**Tue 6/15/10**	**Fri 1/4/13**
15	EZEIZA-SANTIAGO	20 days	Tue 6/15/10	Mon 7/12/10
16	BOGOTA - GUAYAQUIL	20 days	Thu 7/1/10	Wed 7/28/10
17	BOGOTA - PANAMA	20 days	Mon 8/2/10	Fri 8/27/10
18	BOGOTA - BARRANQUILLA	20 days	Thu 9/30/10	Wed 10/27/10
19	BARRANQUILLA - PANAMA	20 days	Mon 11/1/10	Fri 11/26/10
20	SANTIAGO - CORDOBA	20 days	Tue 6/15/10	Mon 7/12/10
21	AMAZONICO-BOGOTÁ	20 days	Mon 8/1/11	Fri 8/26/11
22	LIMA - SANTIAGO	20 days	Mon 6/18/12	Fri 7/13/12
23	LIMA - GUAYAQUIL	20 days	Mon 7/2/12	Fri 7/27/12
24	LIMA - BOGOTA	20 days	Mon 12/10/12	Fri 1/4/13
25	**DOC 44444**	**20 days**	**Wed 12/16/09**	**Tue 1/12/10**
26	AMAZONICO - MAIQUETIA	20 days	Wed 12/16/09	Tue 1/12/10
27	**AIDC**	**804 days**	**Tue 12/15/09**	**Fri 1/11/13**
28	CURITIBA-EZEIZA	20 days	Mon 10/17/11	Fri 11/11/11
29	CURITIBA - MONTEVIDEO	20 days	Mon 1/9/12	Fri 2/3/12
30	EZEIZA-CORDOBA	20 days	Tue 12/15/09	Mon 1/11/10
31	EZEIZA - MONTEVIDEO	20 days	Mon 1/9/12	Fri 2/3/12
32	LIMA - AMAZONICO	20 days	Mon 12/17/12	Fri 1/11/13
33	ASUNCIÓN - CURITIBA	20 days	Mon 3/5/12	Fri 3/30/12
34	ASUNCIÓN - EZEIZA	20 days	Mon 3/5/12	Fri 3/30/12
35	**Intercambio de Datos Radar**	**1625 days?**	**Mon 4/21/08**	**Fri 7/11/14**
36	**Conexión Directa al Centro - ASTERIX**	**1370 days**	**Mon 4/21/08**	**Fri 7/19/13**
37	CORDOBA – SANTIAGO	30 days	Mon 6/11/12	Fri 7/20/12
38	MENDOZA – SANTIAGO	30 days	Mon 6/11/12	Fri 7/20/12
39	EZEIZA – PUERTO MONTT	30 days	Mon 6/13/11	Fri 7/22/11
40	PUNTA ARENAS – C. RIVADAVIA	30 days	Mon 6/10/13	Fri 7/19/13
41	AMAZONICO – BOGOTA	30 days	Mon 12/3/12	Fri 1/11/13
42	CURITIBA – MONTEVIDEO	30 days	Mon 10/11/10	Fri 11/19/10
43	BOGOTA – GUAYAQUIL	30 days	Mon 12/12/11	Fri 1/20/12
44	BOGOTA – PANAMA	30 days	Mon 12/5/11	Fri 1/13/12
45	BOGOTA – BARRANQUILLA	30 days	Mon 4/21/08	Fri 5/30/08
46	BOGOTA – LIMA	30 days	Mon 5/13/13	Fri 6/21/13
47	BOGOTA – MAIQUETÍA	30 days	Mon 4/21/08	Fri 5/30/08
48	BARRANQUILLA – PANAMA	30 days	Mon 6/13/11	Fri 7/22/11
49	BARRANQUILLA – MAIQUETÍA	30 days	Mon 4/21/08	Fri 5/30/08
50	LIMA – SANTIAGO	30 days	Mon 6/13/11	Fri 7/22/11
51	LIMA – GUAYAQUIL	30 days	Mon 6/10/13	Fri 7/19/13
52	LIMA – AMAZONICO	30 days	Mon 6/10/13	Fri 7/19/13
53	ASUNCIÓN – CURITIBA	30 days	Mon 12/3/12	Fri 1/11/13
54	ASUNCIÓN – EZEIZA	30 days	Mon 12/10/12	Fri 1/18/13
55	**ICD Propietário**	**20 days**	**Mon 12/14/09**	**Fri 1/8/10**
56	AMAZONICO - MAIQUETIA	20 days	Mon 12/14/09	Fri 1/8/10
57	Inter-Centro ASTERIX 62,63 (TBD)	1 day?	Mon 3/4/13	Mon 3/4/13
58	**RADNET (TBD)**	**544 days**	**Tue 6/12/12**	**Fri 7/11/14**
59	Especificación	44 days	Tue 6/12/12	Fri 8/10/12
60	Adquisición	200 days	Mon 8/13/12	Fri 5/17/13
61	Instalación	300 days	Mon 5/20/13	Fri 7/11/14
62	**OTRAS**	**1 day?**	**Mon 3/7/11**	**Mon 3/7/11**
63	**SISTRASAG (TBD)**	**1 day?**	**Mon 3/7/11**	**Mon 3/7/11**
64	LA PAZ	1 day?	Mon 3/7/11	Mon 3/7/11
65	GEORGETOWN	1 day?	Mon 3/7/11	Mon 3/7/11
66	PARAMARIBO	1 day?	Mon 3/7/11	Mon 3/7/11
67	ROCHAMBEAU	1 day?	Mon 3/7/11	Mon 3/7/11



Projeto: PLAN ACCIÓN INTERCONEX
Data: Mon 11/16/09

Tarefa | Divisão | Andamento | Etapa | Resumo | Resumo do projeto | Tarefas externas | Etapa externa | Prazo final

APPENDIX B

MEMORANDUM OF UNDERSTANDING FOR THE INTERCONNECTION OF THE AUTOMATED SYSTEMS OF AAA AND BBB

AAA Logo	***MEMORANDUM OF UNDERSTANDING FOR THE INTERCONNECTION OF THE AUTOMATED SYSTEMS OF AAA AND BBB***		BBB Logo
Effective date: 17 SEP 2009		**Pages:** 2 of 24	

Preface

This document defines the Memorandum of Understanding that will allow AAA and BBB to interconnect their air traffic control automation systems. It is based on the documents prepared by ICAO experts on automation.

The two States can revise this document as necessary.

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Approval

MEMORANDUM OF UNDERSTANDING FOR THE INTERCONNECTION OF THE AUTOMATED SYSTEMS OF AAA AND BBB

For AAA

For BBB

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Revisions

Revision / Date	Description	Revised pages
Rev. 0		

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AAA Logo	***MEMORANDUM OF UNDERSTANDING FOR THE INTERCONNECTION OF THE AUTOMATED SYSTEMS OF AAA AND BBB***		BBB Logo
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1. Section 1 - Introduction and Purpose

1.1. Introduction

GREPECAS/15, taking into account the impact that operational errors of the ATC loop between adjacent ACCs have on the safety of air operations, considered, in Conclusion 15/36, that "CAR/SAM States, Territories, and International Organisations should gradually implement the interface for ATC interfacility data communication (AIDC);" and that "ICAO should coordinate, provide assistance for, and do the follow-up on, the implementation of such corrective measures."

The analysis of the problem led to the conclusion that the solution involved an intense use of CNS/ATM technologies, in keeping with ICAO recommendations, especially those concerning the interconnection of automated systems, as described in Document 4444-PANS/ATM, in Section 8.1.6: "*States should, on the basis of regional air navigation agreements, provide for the automated exchange of coordination data relevant to aircraft being provided with ATS surveillance services, and establish automated coordination procedures*".

In this regard, studies were conducted under Projects RLA/98/003 and RLA /06/901 with a view to having an overview of this issue, including obstacles and required action, as well as of the implementation strategy.

The resulting documents are described in Annexes 1, 2 and 3 to the Appendix to this Memorandum.

The main body of this document consists of ten (10) sections and one (1) appendix. The contents of the sections and appendix are summarised below:

a) Section 1 - Presents a brief overview and a statement of purpose;
b) Section 2 – Describes the basic principles guiding the development of this document;
c) Section 3 – Considers the cases in which this Memorandum applies;
d) Section 4 – Describes the version control process;
e) Section 5 – Lists the relevant legislation;

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f) Section 6 – Establishes criteria and restrictions for the use of the information shared by two countries;

g) Section 7 – Presents the operational aspects that must be considered for the interconnection of the automated systems;

h) Section 8 - Presents the technical aspects that must be taken into account for the interconnection of the automated systems;

i) Section 9 - Presents the administrative aspects that must be taken into account for the interconnection of the automated systems;

j) Section 10 - Presents the financial aspects that must be taken into account for the interconnection of the automated systems;

k) Appendix 1 – Technical-Operational Agreement

1.2. Purpose

The goal of this MoU is to provide the planning for the interconnection of the automated systems of the XXXXX ACC in AAA, and the YYYY ACC in BBB, establishing standard procedures covering the respective operational, technical, administrative, and financial aspects.

2. Section 2 - Principles

The following aspects have been taken into account when preparing this document:

1. This Memorandum is a guide for States to enter into bilateral agreements; and

2. This document takes into account the aspects contained in the automated system interconnection documents prepared by Projects RLA/98/003 and RLA 06/901, as well as GREPECAS recommendations.

3. Section 3 - Application

This document applies only to the interconnection of the automated systems of AAA and BBB.

4. Section – Organisation

This is a document through which the participating States will agree, as necessary, to revise or modify its details.

The revision to this Memorandum, or changes to its paragraphs will be coordinated by the participating States.

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5. Section 5 - References

This Memorandum follows ICAO recommendations contained in the following documents:

a) Annex 11 to the Convention on International Civil Aviation

b) Doc 4444

c) Doc 7030

d) Doc 9426

e) Doc 9694

f) Doc 9880 part IIa (AIDC)

g) RLA/98/003 project document

h) RLA/06/901 project document

i) Final reports of the SAM/IG/1 and SAM/IG/2 meetings

6. Section 6 - Confidentiality

Each participating State must take all the necessary measures to ensure the safety, integrity, and confidentiality of the information.

Disclosure of these data to organisations other than those contemplated in this Memorandum may proceed only if previously authorised by the participating States.

7. Section 7 - Operational Aspects

The implementation of this Memorandum may require adjustments to the Operational Agreements that exist between the States.

The Administrations undertake to instruct the staff of the ACCs involved, on the appropriate sections of this MoU.

Priority will be given to automatic hand-off, through the transmission of the required data between automated systems, according to the specifications contained in the Appendix to this MoU.

However, other means of communication can be used for the transfer when automatic hand-off is not possible.

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8. Section 8 - Technical Aspects

The technical aspects to be taken into account by States for the establishment of the interconnection scenarios, the implementation strategy, the implementation of the solution, the supervision of the operation, and the personnel training aspects that will best meet their requirements are shown in Section 6 of the Appendix to this Memorandum.

9. Section 9 - Administrative Aspects

For the orderly implementation of the interconnection solution adopted, the participating States agree to the creation of an administrative structure based on an Interconnection Management Committee, whose functions, detailed composition, and activities are described in Section 7 of the Appendix to this Memorandum.

The States must designate their representatives, members of their respective groups, to make up the basic structure of the aforementioned Committee.

The States must select a forum for discussing cases of non-compliance and for resolving conflicts.

This is an ongoing Memorandum that can be interrupted at any time by common agreement of the parties involved.

10. Section 10 - Financial Aspects

The participating States, as individual administrations, will be responsible for any financial obligation to cover direct or indirect expenditures related to the implementation of this Memorandum, including those associated with the acquisition of equipment, spare parts, training of technical and operational personnel, lines of communication, and others.

Each State will be responsible for its respective portion of expenditures concerning upgrades to the REDDIG to address traffic increases, according to the guidance provided by the REDDIG Administration.

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The parties to this Memorandum understand that they will not commit to any action that could result in a financial obligation for the other parties, without first obtaining the written consent by all the other parties involved.

The States can establish financial mechanisms to carry out the interconnection, for example, through ICAO Technical Cooperation Projects.

AAA Logo	*MEMORANDUM OF UNDERSTANDING FOR THE INTERCONNECTION OF THE AUTOMATED SYSTEMS OF AAA AND BBB*		BBB Logo
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APPENDIX TO THE MEMORANDUM OF UNDERSTANDING

TECHNICAL-OPERATIONAL AGREEMENT FOR THE INTERCONNECTION OF THE AUTOMATED SYSTEMS OF AAA AND BBB

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11. Purpose

To provide a detailed description of the technical, operational, and administrative aspects of the Memorandum of Understanding required for the interconnection of the automated systems of AAA and BBB.

12. Summary

ICAO Projects RLA/98/003 and RLA/06/901 identified resources for the conduction of studies, in order to have a full vision of the interconnection of automated systems, including obstacles, required action, and implementation strategy.

The work carried out included:

- Drafting of the Initial Action Plan – July 2006;
- Concept Test – BBB Trial -Venezuela – September 2006;
- Data collection – Phase 1 – survey of countries – current interfaces;
- Data collection – Phase 2 – missions to the States – details of the interfaces – 2007
  - ✓ 1st mission: Peru, Ecuador, and Venezuela – September 2007;
  - ✓ 2nd mission: Colombia, Panama, and COCESNA – October 2007;
  - ✓ 3rd mission: Chile, AAA, and Uruguay - November 2007
- Drafting of the Interconnection Plan – February 2008;
- Drafting of the SICD document (System Interface Control Document) – March 2008;
- Drafting of the SSS document (System Subsystem Specification) – September 2008

The generated products cover, in summary, the following aspects:

1. SICD: contains all the data collected from the SAM States that have automated systems, as well as a description of their interfaces, providing an overview of the current situation and recommendations for the adoption of the necessary measures for their interconnection.

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2. Interconnection plan: contains the objectives, concepts, strategies, and the action required to meet the operational requirements for the hand-off between adjacent ACCs in the SAM Region.

3. SSS: contains the requirements--especially those that are mandatory--for ACC automation systems, to be used as a reference for future implementations of new air traffic control automated systems and their upgrades, as necessary.

The SICD, the Interconnection Plan, and the SSS documents were submitted for analysis and approval at the following events:

- Interconnection Plan and SICD:
  - ✓ Project RLA 06/901 - First meeting of the SAM Implementation Group (SAM/IG/1),
  - ✓ Sixth meeting of the GREPECAS ATM/CNS Subgroup; and
  - ✓ Seminar/Workshop on ATM Automation – Rio – BBB;
- SSS:
  - ✓ Project RLA/06/901 - Second meeting of the SAM Implementation Group (SAM/IG/2)

13. Reference

This Agreement follows ICAO recommendations contained in the following documents:

a) Annex 11 to the Convention on International Civil Aviation
b) Doc 4444
c) Doc 7030
d) Doc 9426
e) Doc 9694
f) Doc 9880 part IIa (AIDC)
g) RLA/98/003 project document
h) RLA/06/901 project document
i) Final reports of the SAM/IG/1 and SAM/IG/2 meetings

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14. Security

Each State must ensure that its communication networks involved in the interconnection have the protection required for this type of service, taking into account, at least, the following aspects:

- Protection from invasion by unauthorised individuals and/or systems;
- Protection from the attack of computer viruses; and
- Use of the equipment exclusively for the interconnection of the automated systems.

15. Operational Aspects

The Administrations undertake, within their respective jurisdiction, to directly inform the staff of the ACCs involved about the contents of this Memorandum of Understanding.

Priority will be given to automatic hand-off and the provision of radar control service through the transmission of the required data between the automated systems, as specified in this Agreement.

However, other means of communication can be used for the transfer when automatic hand-off is not possible.

Likewise, through the respective operational agreements, the provision of non-radar control services should be coordinated for hand-off between adjacent ACCs when the signals of the radars involved in this Agreement are not available.

The interconnection option chosen implies that the States will have to establish specific operational procedures, taking into account the functionalities available in each automated system, selecting the message set to be used, but complying with the specifications and requirements contained in the documents associated to the solution adopted.

The States agree to jointly define the transition area for the exchange of surveillance data between adjacent ACCs, considering a distance of 55 NM from the boundary of the FIRs involved, for both States.

Special attention must be given to the training of controllers in the use of the tools available in the automated systems concerning automatic hand-off between adjacent FIRs.

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16. Technical Aspects

The interconnection must meet the following requirements:

- It should allow for the automatic transfer of flight plans between adjacent ACCs;
- It should allow for surveillance data sharing in areas of common interest.

The main aspects are:

1) <u>Analysis of the current scenario</u>

According to the information contained in the reference documents, the current status in BBB and AAA is as follows:

1) <u>AAA</u>

a) <u>Automated System</u>

The XXXXXX ACC uses an extension of the XXXX system, installed in XXX, which has the functionality required for the provision of radar surveillance services throughout the XXX FIR, and for the automated processing of flight plans, as described in the SICD.

The XXXX system has automatic flight plan "hand-off" capability, using the messages of ICAO Doc 4444, and can process OLDI and AIDC protocols. It is expected to have Asterix 62/63 capability by XXXX.

b) <u>Radar Display</u>

Radar coverage is currently available in the XXX FIR.

c) <u>Data Network</u>

The XXXXX ACC has access to the REDDIG for oral communication with adjacent ACCs.

Radars will transmit data through the Ethernet and the domestic network, using the Asterix protocol.

The AMHS system has been/will be installed at domestic level and has been operating since/will operate starting in 20xx.

2) BBB

a) Automated System

The XXXXXX ACC uses an extension of the XXXX system, installed in XXX, which has the functionalities required for the provision of radar surveillance services throughout the XXX FIR, and for automated processing of flight plans, as described in the SICD.

The XXXX system has the automatic flight plan hand-off capability, using the messages of ICAO Doc 4444, and can process the OLDI and AIDC protocols. It is expected to have Asterix 62/63 capability by XXXX.

b) Radar Display

Radar coverage is currently available in the XXX FIR.

c) Data Network

The XXXXX ACC has access to the REDDIG for oral communication with adjacent ACCs.

Radars will transmit data through the Ethernet and the domestic network, using the Asterix protocol.

The AMHS system has been/will be installed at domestic level and has been operating since/will operate starting in 20xx.

2) Selection of the exchange scenario

Based on the interconnection levels that exist in the XXXX ACC and XXXX ACC facilities, AAA and BBB agree to adopt the following interconnection possibilities in the short and medium term:

1) Short term: Automatic exchange of surveillance data only;

2) Medium term: Automatic exchange of surveillance data and flight plan data.

The States agree to adopt flight plan transfer based on the ICAO OLDI/AIDC, as foreseen in Section 5 (Concepts for Automated ATC Systems Interconnection) of Annex 2 to this Appendix.

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The States also agree to adopt the exchange of surveillance data based on the Asterix protocol, according to Section 5 (Concepts for Automated ATC Systems Interconnection) of Annex 2 to this Appendix.

3) Implementation Strategy

The interconnection will be carried out in (two) phases:

- Short term: Exchange of radar data using the Asterix protocol, around XXX; and
- Medium term: Automatic flight plan hand-off using the AIDC protocol, and exchange of radar data using the Asterix protocol, around XXXX.

The implementation strategy adopted by the 2 (two) States must take into account the following aspects:

1.1. Analysis of the impact on existing systems;

1.2. Definition of interfaces and means of communication;

1.3. Configuration of logical and physical connections;

1.4. Hardware and software adjustments; and

1.5. Interconnection tests

These aspects will be analysed by the technicians of the Interconnection Management Committee, as established in this Memorandum, and will be described in the corresponding document.

For the short-term phase, the following radars will be used:

- XXXX secondary radar, as described in paragraph 6.1.1.b of this document; and
- Secondary radars of XXXX.

The radar data contained in the transition area described in Appendix "A" to this document will be transmitted.

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The States undertake to provide the necessary technical details for the transmission and reception of the radar signals in each automated system.

Communication between the States will be through the REDDIG.

The medium-term phase will be established by XXX, once the States have the operational capability of using AIDC for automatic hand-off of flight plans.

4) Implementation

The Interconnection Management Committee will carry out the implementation, based on the guidelines issued by common agreement by the States, defining implementation dates, the outsourcing of services, and the distribution of responsibilities, among other relevant matters.

5) Supervision of the Operation

Each State must supervise the operation of its systems, including the maintenance of its equipment and systems, ensuring the required availability, performance, safety, and efficiency.

All the problems of uncertain origin will be jointly analysed by the States through the Interconnection Management Committee, which will coordinate the actions required for their resolution.

However, each State must take all possible steps to implement the actions for which it is responsible, reporting their implementation to the Interconnection Management Committee.

In all cases, the Interconnection Management Committee must be informed at all times about anomalies, regardless of their origin.

6) Training

The participating States must draft training plans for the technical teams responsible for system maintenance, taking into account length, frequency, and technological evolution.

7) Maintenance

Teams must be prepared to face contingencies and be technically capable of analysing anomalies.

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Each State must draft its Action Plan that defines the technical information required for the interconnection with adjacent ACCs, covering, at least, the following:

- the topology of the networks involved, with the technical details about the required bandwidth, availability, latency, and redundancy;
- the specification of the equipment used;
- the maintenance requirements;
- the maintenance procedures--preventive, predictive, and corrective---; and
- all of the related technical documents;

The States agree that the means of communication for the implementation of the interconnection will be the REDDIG.

17. Administrative Aspects

This Agreement is a dynamic document that can be revised at any moment, based on the technological evolution of the automated systems and of the communication networks of the participating States.

The Interconnection Management Committee created by the two (2) States will manage the interconnection, based the following:

1. Organisational Structure

In order to carry out its activities, the Committee will be organised as follows:

1. Coordinator

The names of the coordinators of the interconnection between the systems of AAA and BBB are shown in Annex A.

Coordinators will be responsible for the general coordination of all the activities of the technical and operational groups, as well as for the contacts with other organisations to address matters related to the interconnection.

2. Technical Group

Made up by technicians designated by the two States, with proven skills in their respective areas, especially in communication networks and computer automation systems.

It will be responsible for the implementation and/or coordination, in their respective countries, of the technical activities required for the implementation, maintenance, and support of automated systems, communication networks, and interconnection equipment.

3. Operational Group

Made up by personnel specialised in air traffic control, designated by the two States, with proven skills in their respective areas, especially in the automated systems used in the ACCs.

2. Faculties

The Committee is responsible for coordinating the planning, implementation, maintenance, and support of the operation of the systems and equipment involved in the interconnection of the automated systems.

It must guarantee the safety of the information exchanged between the automated systems involved in the interconnection.

Its faculties include the control and updating of all the technical and operational documentation.

It is also responsible for proposing the network topology to be used in the interconnection, which shall be approved by the two (2) States.

The implementation of the interconnection shall be coordinated and controlled by the Committee, based on action plans previously approved by the two (2) States.

The Committee must advise the States about the need for the technological evolution of the equipment and systems involved in the interconnection, taking into account, *inter alia*, the technical requirements contained in Annex 3 – SSS, to this Appendix.

Its teams must monitor the performance, stability, reliability, and integrity parameters of the equipment and systems involved in the interconnection, and propose and supervise the corrective action. To this end, it must use tools for analysing anomalies, such as radar protocol and communication line analysers.

The Committee shall establish the necessary procedures for correcting failures.

It shall also provide, together with the participating States, for the resolution of the problems encountered.

3. Management Process

In order to carry out its activities, the Interconnection Management Committee will apply the following system:

1. Periodical meetings and discussions to identify requirements and preferred technical solution(s), alternatives, and options for the interconnection of the automated systems;
2. The exchange of technical reports and documents, plans and programmes to ensure the successful and timely culmination of these efforts.
3. Joint planning, technical coordination, and development of activities between the two (2) States.

18. Financial Aspects

With respect to financial aspects, the States agree to the following:

1. Acquisition of equipment, components and systems

The equipment required for the interconnection will be acquired by each State, in keeping with the technical specifications approved by the Interconnection Management Committee;

2. Acquisition of spare parts

Spare parts for the equipment used in the interconnection will be acquired by each State, according to its specific needs, but in keeping with the maintenance guidelines issued by the Interconnection Management Committee.

3. Acquisition of services from third parties

Each State agrees to cover the expenditures involved in the hiring of third-party services, such as software adaptations, projects, and implementation of communication networks.

Each State will be responsible for its respective portion of any expenditure concerning upgrades to the REDDIG to support traffic growth, according to the guidelines of the REDDIG Administration.

19. Attachments

1. Preliminary System Interface Control Document for the Interconnection of ACC Centres of the CAR/SAM Regions – SICD;

2. CAR/SAM Automated ACC Interconnection Plan;

3. Preliminary Reference System/Subsystem Specification SSS for the Air Traffic Control Automation System.

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ANNEX A

AUTOMATED SYSTEM INTERCONNECTION MANAGEMENT COMMITTEE

AAA

BBB

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ANNEX B

RADAR DATA TRANSITION AREA BETWEEN THE XXX AND THE YYY ACCs

APPENDIX C

PROCEDURES FOR THE INTEGRATION OF RADAR DATA INTO THE ATM AUTOMATED SYSTEM

1. Objective

Describe the basic procedures for the integration of radar signals into the ATM automated system in order to ensure the quality of the radar synthesis shown on the air traffic control display.

2. Scope

This document applies to all SAM States that will interconnect their ATM automated systems for the exchange of radar data.

3. Overview

Such display allows controllers to optimise the use of the airspace under their responsibility, once the quality of the information associated to the tracks is ensured.
The integration of a radar into an ATM automated system must, therefore, be subject to a technical and operational validation, involving the verification of all the systems involved: the radar itself, the communication interfaces, the data transmission systems, and the ATM automated system.

4. Procedures

It basically consists of procedures for mono-radar and multi-radar evaluation, as follows:

1. Mono-radar evaluation

The objective is to check the correct operation of the automated system in terms of reception, processing, and display of data, and the correct operation of the radar and the communication system. The following activities should be carried out:

A. Preliminary actions

In order to conduct the tests, the teams involved in the interconnection must observe the technical condition of the data in each radar system, the software version used by the automated system, the adjustments to the automated system database, the stability of communication lines, the azimuth and distance adjustments for each radar to be integrated into the automated system and the conduction of preliminary tests.

B. Mono-radar integration tests

These consist of radar management tests, accompanying opportunity flights and, if possible, manned flights with an aircraft used for specific trials.

- Radar management: Observation of radar and automated system reactions upon disconnection and/or changes in communication lines.

- Opportunity flights: Observation of the behaviour of the radar integrated into the automated system, looking for radar display anomalies, such as duplication, merging of synthesis tracks, false tracks, and transponder code changes in one same aircraft.

- Manned flight: If possible, conduction of trials that involve changes in speed, level, transponder code (special codes), bow evolution (complete curves), and heading (distance and azimuth with respect to radar head). A flight test aircraft that can do the procedures in a pre-defined path, preferably the radial with the best radar detection, will be necessary.

2. <u>Multi-radar evaluation</u>

The purpose is to observe the quality of the radar synthesis information of the automated system, that is, the radar sub-system processing, as well as the validation of the database (mosaic definitions, radar coordinates, etc).

This assessment can be done through opportunity flights or a manned flight, with a dedicated aircraft that follows a pre-defined path, with the coverage by all the radars involved in the radar synthesis that is to be assessed.

The assessment basically involves comparing the coordinates (LAT, LONG) provided by the automated system with the coordinates provided by the system on board the aircraft being used (whether opportunity or manned flight).

Consideration is also given to anomalies in the synthesis display, such as track diffusion, changes in the transponder codes, delays in data updating.

5. Implementation Strategy

1. <u>Planning</u>

This phase defines which radars will be part of the control centre synthesis, taking into account the operational requirements, such as the type of operation and coverage required by level and type of detection (primary, secondary, or associated).

Based on the requirements, a preliminary study is conducted to check which radars provide a better service, also taking into account an initial assessment of the technical condition of each radar, and the number of failures, the status of conservation and maintenance.

Once the radars have been defined, a final version of the procedures to be applied is prepared, including the tests, flight paths, and equipment involved (radar, communication, software, etc.).

2. <u>Coordination</u>

Based on the planning, the coordination of the work starts with a meeting attended by the representatives of the technical and operational areas involved.

This activity is carried out by an integration coordinator, who is responsible for the contacts and for accompanying, together with the experts from each area, the conduction of the tests, as well as for the completion of the work.

3. Analysis

Based on the data obtained from the tests, an expert on radar processing makes the technical assessment for obtaining the technical approval.

The same thing applies to the assessment of operational aspects by the expert on air traffic control of the control centre.

4. Validation

Based on the technical and operational assessments, the integration is approved and certified, and the system is ready to operate.

APPENDIX
STRATEGY FOR THE IMPLEMENTATION OF AMENDMENT 1 TO THE 15TH EDITION OF THE ICAO PANS-ATM (DOCUMENT 4444) IN THE SAM REGION

TABLE OF CONTENTS

DATE: 9OCT09

1. Objective

The purpose of this document is to establish the SAM strategy for the implementation of Amendment 1 to the 15th Edition of the ICAO PANS-ATM (Doc 4444), pursuant to conclusions 15/35 of GREPECAS and SAM/IG/3-8.

2. General considerations

ICAO, taking into consideration that:

- Dynamic management of information will provide the most appropriate and integrated vision of ATM status in historical terms--past, present, and planned or future---and will serve as a basis for decision-making by the whole ATM community;

- The *Global Air Traffic Management Operational Concept* (Doc 9854) requires information management actions to support ATM operations with accurate, quality, and timely information; and

- ATM requirement N^{o} 87 of the *Manual on Air Traffic Management System Requirements* (Doc 9882) defines that 4-D paths will be used in traffic synchronisation applications, with a view to attaining the performance objectives of the ATM system. It also clarifies that automation in both “ground” and “air” applications will be fully used to create an efficient and safe air traffic flow in all flight phases.

Informed the States, through letter AN13/2.1-08/50 of 25 June 2008, about the publication of Amendment 1 to Doc. 4444 (PANS-ATM), aimed at updating the ICAO flight plan (FPL) form to meet the needs of aircraft with advanced capabilities and the evolving requirements of automated air traffic management (ATM) systems, while taking into account compatibility with existing systems, human factors, training, cost, and transition aspects.

GREPECAS/15, when assessing the establishment of the new CNS/ATM Subgroup and its terms of reference and work programme, reviewed the new flight plan model. In this regard, considering that a CAR/SAM regional strategy will need to be established for its implementation, it formulated Conclusion 15/35 “*Implementation of the new ICAO flight plan model*” requesting States to adopt the necessary measures to prepare for the transition, and also requesting the CNS/ATM//SG to establish a contributory body to develop such transition strategy.

The SAM/IG/2 meeting analysed the impact that this amendment could have on automated systems, taking into account PBN implementation. It was noted that the amendment in question was complex and involved other aspects besides PBN. Consequently, the meeting deemed it necessary to adopt a strategy for the modification of automated ATC systems.

In view of the above, the meeting agreed to include a task in the work programme of the SAM PBN Implementation Group, related to the assessment of PBN implementation in light of Amendment 1 to the PANS-ATM. This activity would serve as support and reference to the work entrusted to the aforementioned specific task force of the GREPECAS CNS/ATM/SG. Accordingly, a task was included in the work to be carried out in 2009 under the auspices of Regional Project RLA/06/901 in the SAM Region.

At the SAM/IG/3 meeting, States were presented with the ICAO directives for the incorporation of flight plan information, in accordance with Amendment 1 to the Procedures for air navigation services — Air traffic management, 15th edition (PANS-ATM, Doc. 4444).

Conclusion SAM/IG/3-8 considered that project RLA/06/901 should develop an initial plan, together with a description of the strategy for the implementation of said amendment, to be presented at the SAM/IG/4 meeting.

3. Principles

In preparing this document, the following aspects have been considered:

1. The sovereign will of the States;

2. It is a guide for SAM States to develop their action plans for the implementation of the contents of Amendment 1 to Doc. 4444.

4. Scope

This document applies to all SAM States, specifically to all air navigation service providers and airspace users.

5. Reference documents

This strategy follows ICAO recommendations, as contained in the following documents:

a) ICAO PANS-ATM, 15th Edition (Doc 4444)

b) Amendment 1 to the 15th Edition of Doc 4444;

c) Directives for the incorporation of flight plan information, pursuant to Amendment 1 to the Procedures for air navigation services - Air traffic management, 15th edition (PANS-ATM, Doc 4444)(State letter AN 13/2.1-09/9 of 6 February 2009);

d) GREPECAS 15 final report; and

e) Final reports of the SAM/IG meetings.

6. Analysis

6.1. Amendment 1 to the 15th edition of Doc 4444;

ICAO considered that, in order to meet the needs of aircraft with advanced capabilities and the evolving requirements of automated air traffic management (ATM) systems, the flight plan forms need to be updated.

In this regard, it published Amendment 1 to PANS-ATM, Doc 4444 - 15th Edition, which contains, basically, the following changes:

1. Flight plan

    a. Flight plan form: operators and air traffic service units should comply with the restrictions established in aeronautical information publications (AIPs);

    b. Filing of flight plan: changes in the deadlines for filing flight plans;

    c. Item 7: Aircraft identification: use of alphanumeric characters;

    d. Item 8: Flight rules: specification of one or more items of change in flight rules;

    e. Item 10: Equipment: changes in the designation of equipment and capabilities

    f. Item 13: Aerodrome of departure and time

    g. Item 15: Route

    h. Item 16: Aerodrome of destination and total estimated duration, alternate destination aerodromes

    i. Item 18: Other data

2. Messages from air traffic services

    a. Composition of CHG, CNL, DLA, DEP, RQP and RQS messages

6.2. Implementation directives

In Letter AN 13/2.1-09/9, dated 6 February 2009, ICAO defines the directives for the incorporation of flight plan information pursuant to Amendment 1 to the Procedures for air traffic services.

In general, ICAO highlights that the changes have significant repercussions for ANSP flight data processing systems that check and accept flight plans and related messages, use flight plan data from displays as a reference for controllers, use data for ANSP automation, and facilitate communications among ANSPs during flight, and also have consequences for airspace users.

Although a date has not been established for the implementation of flight planning changes, the transition is expected to begin on 25 June 2008 and finish on 15 November 2012.

It also recognises that the changes will be applied according to timetables specific to each ANSP and airspace user, based on their own needs, but there shall be some coordination.

Finally, it stresses that all those involved should be in a position to submit and process flight information in keeping with Amendment 1 to the PANS-ATM by 15 November 2012.

Some considerations regarding the planning environment follow:

1. EXISTING means the existing flight planning formats and ATS messages defined in the current version of the PANS-ATM;

2. NEW means the flight planning formats and ATS messages specified in Amendment 1 to the PANS-ATM;

3. The ATM system shall support simultaneously the EXISTING and NEW information for some period of time, in order to have time to deal with individual performance cases;

4. Amendment 1 does not change the filing of flight plans through different means (individual filing of flight plans before each ANSP, filing of flight plans at one location and then the ATM system distributes them), but the transition to the implementation of Amendment 1 might entail some requirements during the transition period;

5. The Amendment makes changes to the content of flight plan messages exchanged between ANSPs.

A summary of the contents of ICAO directives follows:

Directriz 1. Recommends that ANSPs be capable of operating with the two types of flight plan information, EXISTING and NEW, during the transition period. ANSPs are not required to accept and process EXISTING data after 15 November 2012. It applies to cases in which some ANSPs and/or airspace users do not implement flight plan changes until the end of the transition period.

Directriz 2. Regional planning and implementation groups are encouraged to plan and publish the changes sufficiently in advance to the date of application. It considers that transition plans should take into account the fact that it is possible that airspace users will not be able to use the new opportunities offered by the NEW information until such time that the ANSPs have made the transition and, even then, the use of the NEW information could be limited in its application if flights continue to involve ANSPs that have not made the transition yet.

Directriz 3. Clarifies that airspace users will determine whether they will submit NEW or EXISTING information to the ANSP during the transition period and after the ANSP has notified that it can accept the NEW information.

Directriz 4. In the event that not all ANSPs have made the transition to the NEW information, airspace users must make sure that the EXISTING information is submitted to the ANSPs that have not made the transition yet. It stresses the concern that ANSPs that use EXISTING information might misinterpret and reject the information submitted by airspace users more than 24 hours before the flight, as well as the case in which ANSPs that use the NEW information will not be in a position to transmit essential coordination to the ANSPs that use the EXISTING information.

Directriz 5. Informs that ICAO will maintain a website containing the list of capabilities of each ANSP to accept EXISTING or NEW information. Each ANSP will communicate to the respective ICAO Regional Offices, as soon as possible, its capability of accepting the NEW information.

Directriz 6. To supplement Directive 4, it is noted that the ANSPs that accept the NEW information could translate flight information into EXISTING information for purposes of coordination with adjacent ANSPs that have not made the transition.

6.3. Current scenario in the SAM Region

Currently, the SAM Region shows different levels of technological evolution in terms of ATM automation, which can be classified into the following groups:

- SAM States that have automated systems (radar data and flight plan processing) in the following ACCs: Argentina, Brazil, Chile, Colombia, Ecuador, French Guiana, Panama, Peru, Uruguay and Venezuela. Many of the automated systems installed in the Region are based on the AIRCON (INDRA) solution, but in different versions;

- States that have ATM automated systems and are in the process of updating them, like Brazil and Peru;

- States that do not have ATM automated systems, but are in the phase of implementing them in the short term, like Guyana, Suriname and Paraguay.

- States that do not have ATM automated systems and no short- or medium-term plans to purchase them, like Bolivia.

The implementation strategy must take into account the different degrees of evolution in the Region.

The main means used for the transmission of flight plans in the Region is the AFTN, which is in the process of transition to the AMHS system. It is expected that, by 2012, all SAM States will have the AMHS system installed. The means of communication used for the transmission of AFTN information in the Region is the REDDIG.

6.4. Impact

Based on the changes defined by ICAO, on the directives for the implementation of these changes. and on the current scenario of the SAM Region, a macro analysis is made of the impact on ATM systems, whether automated or not, as well as on data communication systems, both at the technical and operational level.

6.4.1. Technical impact

For States that do not have ATM automated systems, the changes in the new flight plan format would only affect data communication systems based on the AFTN or the AMHS, basically associated to the human-machine interface at the system terminals available at AIS offices and other specific locations for the entry of flight plans.

It must be noted that changes in the flight plan format involve the introduction of more options for filling the boxes in the form, and this could imply more errors in the generation of messages from terminals, which do not have the capability of checking data consistency, only message syntax.

It must be noted that these changes in the flight plan form introduce many options that can increase the likelihood of errors when completing it.

In States that have ATM automated systems, changes have a significant technical impact, and it will be necessary, at least, to make adjustments in the sub-systems dealing with flight plan processing, communication interface with other systems, recording and re-display, and in the HMI of control displays.

Such adjustments must take into account, at least, the following aspects:

- The incorporation of all the changes contained in Amendment 1 and described in item 6.1 of this document;
- The provision to the air traffic controller of all the information required for air traffic planning and management, including the alerts of aircraft capability changes;
- Enabling the correct transmission of flight plan information, EXISTING of NEW, to all the control centres involved;
- A clear definition of box sizes and their respective sub-divisions, as well as data sequencing (for example, the sequence for the inclusion of data in Box 10);
- Including the updating of all the technical documentation of the system; and
- Early testing to validate the changes.

Consequently, the effort of modifying these systems must be considered, also taking into account the difficulties inherent to technological obsolescence and insufficient technical training of maintenance personnel, which may cause additional financial expenditures due to the need to hire third parties, and a higher risk of failure.

For States that are in the process of purchasing new automated systems, whether or not for changing the existing systems, the impact will be on the specification of such systems, which must be suitable to process the changes defined in the amendment.

Another important aspect is that ICAO considers a period of transition, in which ANSPs must be capable of processing EXISTING and NEW information, which implies making adjustments to the software so that it can recognise what format is being used.

6.4.2. Operational impact

The changes have a direct impact on operational personnel, especially air traffic controllers and flight plan operators.

However, many variables need to be considered, as well as the relationships between the data in the different boxes of the FPL (for example, boxes 10 and 18), which may change depending on aircraft status.

This impact is reduced if the ATM automated system can provide the air traffic controller with the information required for air traffic planning, and send alerts whenever there is a change in the scenario with respect to the data declared in the flight plan.

Consideration should also be given to the operational difficulty that will exist during the transition period, when it must be possible to operate with the two types of information: EXISTING and NEW

It is also necessary to clearly and formally define those aspects that are not totally defined in Amendment 1 and in the directives; for example, the use of item COM/NAV, in Box 10, where the letter S represents VHF RTF, VOR or ILS standard equipment, without making reference to NDB.

In order to mitigate the impact, a significant amount of training must be provided to the personnel on both the use of the new resources of the automated system and the manual processing of flight plan data, as well as on the adjustment of operational models and the clear definition of controversial issues.

7. Implementation strategy

7.1. Critical criteria

The following aspects must be taken into account for the implementation of Amendment 1 in the SAM Region:

- Make sure that, by 15 November 2012, all States and airspace users implement all the changes contained in Amendment 1, and not just some selected aspects;

- States that do not fully implement the amendment will be obliged to publish the non-conformities in their AIPs as "SIGNIFICANT DIFFERENCE" before 15 November 2012. Likewise, failure to implement the changes will be considered as a deficiency and will be included in the List of Deficiencies of the SAM Region; and

- Make sure that, as of 15 November 2012, <u>all</u> States and airspace users will accept and disseminate only information of the NEW flight plan format and of associated ATS messages, and that the capability of processing the EXISTING format is deactivated.

7.2. Preparation

In order to succeed in the implementation of the changes, SAM States need first to develop an action plan that takes into account the impact of the change on their systems, taking into consideration the aspects included in this strategy.

In order to succeed, the States, under the coordination of the ICAO Regional Office and GREPECAS, need to develop their action plans based on the impact on their systems, taking into account the changes, directives and critical criteria defined above.

Such plans must contain, as a minimum, the following topics:

- Classification of the level of evolution of their systems;

- A detailed assessment of the technical and operational impact;

- The solution to mitigate the impact, with the respective implementation timetable and those responsible for its execution;

- Deadline for the implementation of the solutions;

- Solution validation tests;
- Technical and operational training programmes; and
- Contingency measures.

Such plans must be submitted to the SAM/IG/5 meeting.

The ICAO SAM Regional Office will monitor the following tasks:

TASK	START	END	RESPONSIBLE PARTY
Ensure that automated system requirements contain all the changes of the FPL form	2009	2012	Each State will indicate who is the responsible party
Ensure the proper modification of ATM automated systems for a correct analysis of the information, and the identification of the order in which messages are received, to make sure that there are no data interpretation errors.	2009	2012	Each State will indicate who is the responsible party
A comparative analysis between flight plan data processed in the NEW format and the same data treated in the EXISTING format.	2010	2011	Each State will indicate who is the responsible party

States must also agree on a joint definition of any items that are not clearly specified in the amendment before making adjustments to their systems.

7.3. Transition

The action taken in this transition phase must:

- Follow GREPECAS guidance;
- Follow the ICAO directives described in paragraph 6.2;
- Act together with the implementation coordinator;
- Carry out the activities foreseen in the action plan to mitigate technical and operational impact;
- Recognise that airspace users will only obtain benefits if the changes are implemented jointly.

In the SAM Region, the transition period during which the ANSPs must be capable of processing both flight plan formats--EXISTING and NEW--starts on 18 July 2011 and ends on 15 November 2012.

However, States are urged to complete the implementation of the NEW format between 18 July 2011 and 20 July 2012, and not to use this NEW format before the transition period.

Therefore, States must maintain coordination with respect to the evolution of action plans, and report any changes in dates, deadlines, etc.

Likewise, airspace users must take steps to adjust their systems in a precise and correct manner, in accordance to the NEW and EXISTING flight plan formats.

Implementation coordination meetings will be held periodically in order to assess the plans, ending with the meeting to be held on 15 June 2011 to decide on the start-up of the transition.

Each State shall designate a contact person to coordinate with ICAO and other States during the transition to the new flight plan format.

7.4. Post-transition

States must discontinue the processing of the EXISTING flight plan format on 15 November 2012.

They must also ensure that ATM systems, whether or not automated, process all the information contained in the NEW flight plan format correctly, and provide support for their operation.

Any difficulties observed must be assessed and resolved by the parties involved, ANSPs and/or airspace users.

8. Administrative aspects

States must assess all the documents involved, including Letters of Operational Agreement, Contingency Plans, and Operational Models.

For all purposes, this document establishes the following process:

1. Periodic meetings and discussions to identify requirements and preferred technical solution(s), alternatives, and options for the implementation of the new flight plan format;

2. The exchange of reports, technical documentation, plans and programming required for ensuring a successful and timely implementation.

3. Planning, technical coordination and implementation of activities by the States, under the coordination of the ICAO Lima Office.

9. Financial aspects

The participating States, as individual administrations, will be responsible for any financial obligation to cover direct and indirect expenditures related to the implementation of this strategy, including those related to the acquisition of the equipment, spare parts, training of technical and operational personnel, lines of communication, and others.

Expenditures related to a possible updating of the REDDIG to support any traffic increase will be equally distributed among the States involved.

States may establish mechanisms for the implementation of this strategy; for instance, through ICAO technical Cooperation projects, under the coordination of the ICAO SAM Office.

Agenda Item 8: Other business

RNP AR Procedure at the Cuzco Airport

8.1 The Meeting was informed on the RNP AR APCH procedure which was designed by the Peruvian aeronautical authority, with the assistance of NAVERUS for the Cuzco airport. The effort made by CAD Peru and LAN Peru could be noted in the process of implementation. It is expected to definitively approve the same by the second half of 2009.

RAIM predictions, ARINC 424 and EMBRAER presentations

8.2 During the Meeting, information was received on RAIM-predictions based on RAIM for RNAV 1 and RNAV 2, using GPS TSO-C129 presented by Mr. Lou Volchansky, Aerospace Engineer, AR-130 from the Federal Aviation Administration (FAA) from United States.

8.3 Also, Mr. James E. Terpstra, Senior Corporate Vice President (retired) from Jeppesen and currently Executive Aviation Adviser made a presentation on RNAV (GNSS) procedures and regulation ARINC 424.

8.4 Also, Ms. Cecilia Dias Lima, Flight Operations Engineer from EMBRAER, Brazil, presented the points of view of an aircraft constructor on requirements for avionics modification in EMBRAER aircraft.

8.5 The Meeting expressed its gratitude to the three lecturers and given the importance of the matters dealt with, the Secretariat was requested to upload these presentations to the SAM Regional Office website.