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PERFORMANCE-BASED NAVIGATION (PBN) IMPLEMENTATION IN THE BRAZILIAN AIRSPACE

1 PRELIMINARY ARRANGEMENTS

1.1 PURPOSE

This Aeronautical Information Circular (AIC) aims to disseminate the concept of Performance-based Navigation (PBN) in Brazilian Airspace, as well as general and specific procedures to be followed by the pilots in command and ATC units of the Brazilian Airspace Control System (SISCEAB).

1.2 SCOPE

This Aeronautical Information Circular (AIC) applies to all those who, in the performance of their duties, may use the Area Navigation (RNAV) and/or Required Navigation Performance (RNP) in the Brazilian Airspace.

1.3 ABBREVIATIONS

ANAC	National Civil Aviation Agency
ATS	Air Traffic Service
ATC	Air Traffic Control
CCO	Continuous Climb Operation
CDO	Continuous Descent Operation
CFIT	Controlled Flight Into Terrain
CO2	Carbon Dioxide
DECEA	Department of Airspace Control
DME	Distance Measuring Equipment
FIR	Flight Information Region
FPL	Filed Flight Plan
GNSS	Global Navigation Satellite Systems
ILS	Instrument Landing System
LNAV	Lateral Navigation
NDB	Non-Directional Beacon
OACI	International Civil Aviation Organization
PBN	Performance-based Navigation
RNAV	Area Navigation
RNP	Required Navigation Performance

RPL	Repetitive Flight Plan
SID	Standard Instrument Departure
SISCEAB	Brazilian Airspace Control System
STAR	Standard Instrument Arrival
TMA	Terminal Control Area
VNAV	Vertical Navigation
VOR	VHF Omni-Directional Beacon

2 PBN OPERATIONAL IMPLEMENTATION

2.1 ICAO has developed a series of activities aimed at the implementation of a Global ATM System, in order to meet the needs related to air traffic growth and major global harmonization and interoperability.

2.2 Harmonization and interoperability seek homogeneity of equipment that can meet the requirements established for air navigation, ensuring safety, efficiency and regularity of air operations.

2.3 In order to meet national needs and to ensure that this development is harmonious and integrated into ICAO planning, DECEA conceived the DCA 351-2 (National ATM Concept of Operations) and PCA 351-3 (National ATM Implementation Plan). This is the challenge of the SIRIUS program, which, in the scope of SISCEAB, represents projects and activities required to implement the ATM Concept of Operations in Brazil, in order to meet the expectations of all the ATM Community and justify the investments required by its members.

2.4 The various developments contemplated by the SIRIUS Program relate to different areas of the ATM System. The project "PBN Operational Implementation" aims to meet a number of operational benefits, such as increasing the safety of air navigation and the efficient use of airspace.

3 PERFORMANCE-BASED NAVIGATION CONCEPT

3.1 Performance-Based Navigation specifies the RNAV system performance requirements for aircraft operating on an ATS route, on an instrument approach procedure or in a designated airspace.

3.2 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. The performance requirements are identified in navigation specifications, which identify the sensors and equipment that can be used to satisfy such requirements.

3.3 There are RNP specifications and RNAV specifications. An RNP specification includes a requirement for on-board navigation performance monitoring and alerting, and is designated as RNP "X", in which "X" is the accuracy value associated with navigation performance. An RNAV specification, in turn, does not have the requirement for on-board navigation performance monitoring and alerting, and, in the same way, it is designated as RNAV "X".

3.4 The PBN depends on:

a) The installation in the aircraft of the RNAV system, which will be approved to meet the functional and navigation performance requirements specified for RNAV and/or RNP operations in a particular airspace;

b) Flight crew compliance with the operational requirements established by the RNAV operations regulatory entity;

c) A defined airspace concept, which includes RNAV and/or RNP operations; and

d) Availability of an adequate air navigation aid infrastructure.

3.5 The main benefits of PBN are as follows:

a) Increased airspace safety through the implementation of continuous and stabilized descent procedures with vertical guidance, enabling a significant reduction in events of controlled flight into terrain (CFIT);

b) Reduced aircraft flight distance and time due to the implementation of optimal flight paths, independent of the ground-based air navigation aids, reducing fuel consumption;

c) Use of the RNAV and/or RNP capabilities already installed on a significant percentage of the aircraft fleet flying within the Brazilian airspace;

d) Optimization of airport and airspace arrival paths in all weather conditions, making it possible to prevent critical terrain conditions through the use of RNAV and/or RNP paths and the resulting reduction of ceiling and visibility operating minima;

e) Implementation of more precise approach, departure and arrival paths that will reduce dispersion and provide more predictable traffic flows;

f) Reduced delays in high-density airspaces and airports through an increase in the ATC and airport capacity, provided by the implementation of parallel routes, new arrival and departure points in terminal areas and approach procedures with lower operating minima;

g) Increased ATC capacity, with potential reduction in the separation between parallel routes to accommodate more traffic on the same flow;

h) Decreased ATC and pilot workload, considering that the use of RNAV and/or RNP paths will reduce the need for radar vectoring and, therefore, the time spent on Pilot/ATC communications; and

i) Less impact on the environment by reducing CO2 emissions through procedures with less distance flown and reducing noise emissions by means of aircraft paths in optimized descent/climb profile and procedure design over unpopulated areas.

3.6 The ICAO Performance-Based Navigation (PBN) Manual (Doc 9613) establishes several Navigation Specifications that can be applied in world-wide level.

3.7 The air navigation procedures cited in this AIC shall only to be followed by operators and aircraft approved by the State of the Registry/Operator, as applicable. The approval process for Brazilian operators and aircraft is established by ANAC.

3.8 The use of the navigation specifications and navigation systems described on this AIC must follow the occasional restrictions prescribed for the approval of aircraft and operators issued by the Civil Aviation Authorities.

4 EN-ROUTE PROCEDURES

4.1 Considering the air traffic characteristics in the South American Region, for continental en-route operations, taking into account the requirements for approval of aircraft and operators, all of RNAV routes in the Amazônica, Brasília, Curitiba and Recife FIR are RNAV 5.
3.2 All RNAV oceanic routes deployed in the EURO/SAM corridor located in the Atlântico FIR are RNAV 10.

4.2 All RNAV oceanic routes implemented in the EURO/SAM corridor located in Atlantic FIR are RNAV 10.

4.3 Only approved RNAV 5 and RNAV 10 (airworthiness and operations) operators and aircraft will be allowed to operate on RNAV routes in the continental or oceanic Brazilian Airspace, respectively.

5 RNAV STAR AND SID PROCEDURES

5.1 The RNAV STAR and RNAV SID may be followed by aircraft and operators that are approved for one or more of the following navigation specifications: RNAV1 and RNP1.

5.2 In the case of aircraft not equipped with GNSS, some procedures can be performed with the use of DME/DME or DME/DME/IRU. When the use of these navigation systems is authorized, the sensors will be described in a chart.

5.3 In specific cases, DME coverage may not be sufficient to meet the requirements for RNAV1 or RNP1 with the use of the navigation system based on DME/DME. In this case, operators wishing to use the RNAV STAR and RNAV SID, with the implementation of the RNAV1 or RNP1 navigation specification, must mandatorily employ GNSS.

5.4 Aircraft operation in RNAV STAR and RNAV SID, based on RNAV 1, will be conditioned to the use of the ATS Surveillance System by the ATC units involved.

5.5 With the implementation of the PBN Concept, the STAR were prepared according to the concept of OPEN STAR and/or CLOSED STAR.

a) OPEN STAR is the instrument arrival procedure which, in the last waypoint/fix, has a defined path, usually parallel to the runway and opposite to the landing direction, from which the aircraft waits vectoring by ATC to intercept the final approach.

b) CLOSED STAR is the instrument arrival procedure which does not have a defined path, mentioned in item a) above. The last STAR waypoint/fix coincides with the Initial Approach Fix (IAF); thus, the aircraft starts the approach procedure after the arrival procedure.

5.6 Some procedures may have the possibility of open or closed STAR in the same chart. The open STAR procedure will be used when an approach procedure is not authorized, because of the need of air traffic sequencing.

5.7 At any point of the STAR an aircraft may be vectored if necessary, in accordance with the provisions in the legislation in force, regardless of the concept of open or closed STAR.

5.8 The terms "OPEN STAR" and "CLOSED STAR" should not be used in the phraseology during radiotelephony communications.

5.9 For an open or closed STAR, in the event of communications failure, before reaching the Initial Approach Fix (IAF), if the aircraft has not received ATC clearance, it should complete the planned approach procedure, when reaching IAF.

5.10 For an open STAR, in the event of a communications failure, the aircraft must follow the instructions for communications failure published in the chart. In case of radar vectoring different from the one published in the STAR, the aircraft shall follow the procedure for communications failure which will be mandatorily informed by the ATC unit.

5.11 In the case of a closed STAR, in the event of a communications failure, the aircraft at the IAF must complete the planned approach procedure.

5.12 In case of communications failure, during the STAR procedure with radar vectoring, the aircraft shall follow the procedure for communications failure which will be mandatorily informed by the ATC unit.

5.13 STAR procedures have been developed to incorporate the concept of Continuous Descent Operations, in order to allow the use of optimum flight profiles. The adoption of this concept is subject to the complexity of the airspace.

5.14 With the implementation of the PBN Concept, the SID were prepared according to the concept of MINIMUM CLIMB GRADIENT and ATC GRADIENT:

a) MINIMUM CLIMB GRADIENT is the angle, expressed in percentage, the aircraft should maintain so as to achieve the minimum safety altitude over obstacles during the departure procedure. If not stated in the chart, the standard minimum climb gradient (3.3%) should be followed.
NOTE: The minimum climb gradient will always be published when greater than 3.3%.

b) ATC GRADIENT is the angle, expressed in percentage, the aircraft should maintain so as to achieve the ATC safety altitude during the departure procedure avoiding potential conflicts with other aircraft. It is established in a defined airspace, in order to ensure the safety and flow of air operations. In a departure procedure, the ATC gradient should always be followed. The aircraft can employ a gradient smaller than the ATC gradient, with authorization of the ATC unit, but never below the minimum climb gradient. For using a gradient below the ATC gradient, the aircraft must request authorization from the appropriate ATC unit prior to takeoff.

NOTE: The ATC gradient will always be published.

5.15 SID procedures have been developed to incorporate the concept of Continuous Climb Operations, in order to allow the use of optimum flight profiles. The adoption of this concept is subject to the complexity of the airspace.

5.16 In the context of complex TMA, even with the use of optimal departure and arrival profiles, intersections between these procedures may occur, causing ATC altitude restrictions. These altitudes must necessarily be followed, except when authorized by the ATC.

6 APPROACH PROCEDURES

6.1 The RNAV approach procedures (GNSS) may only be followed by aircraft and operators that are approved for the RNP APCH Navigation Specification with LNAV/VNAV or only LNAV.

6.2 Some Brazilian airports are equipped with ILS procedures, in which the initial and intermediate segments are based on RNP APCH. The implementation of these procedures also requires approval for RNP APCH.

7 REDESIGN OF AIR TRAFFIC FLOW IN TMAS

7.1 The redesign of the air traffic flow in TMA, based on arrival and departure procedures, was established through the concept of airspace design called "Four Corner".

7.2 The air flow in the "Four Corner" Concept is established based on a fictitious square, centered on the aerodrome, oriented according to the position of aerodrome runways. From this square, a system of arrival and departure routes and procedures is developed.

7.3 Arriving aircraft enter airspace at any of the four corners of the square. Departing aircraft will exit the box on any of the sides (Figure 1).

7.4 This new procedure structure increases air traffic efficiency in the TMA airspace, and the intersections occur near the aerodrome and in a well-defined way, facilitating the use of CCO and CDO techniques.

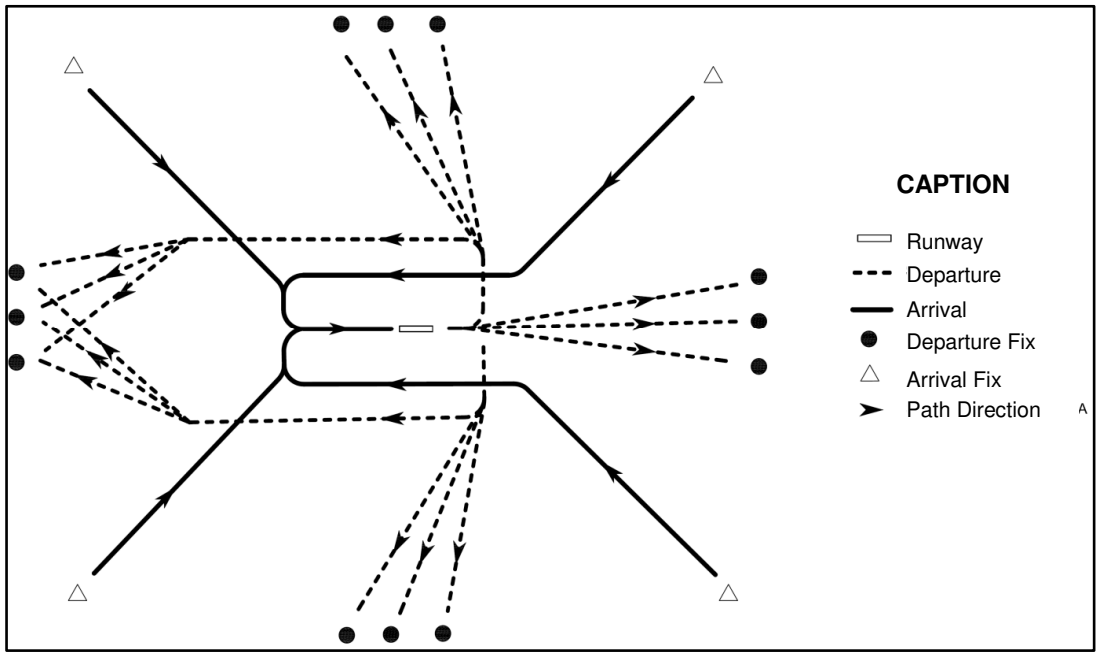

Figure 1 – “Four Corner” Concept

7.5 All altitude restrictions established in the chart, referring to intersections between procedures, will take place before or after the nominal crossing point, as appropriate. (Figure 2)

These restrictions ensure the intersection while maintaining the regular distance and level separation.

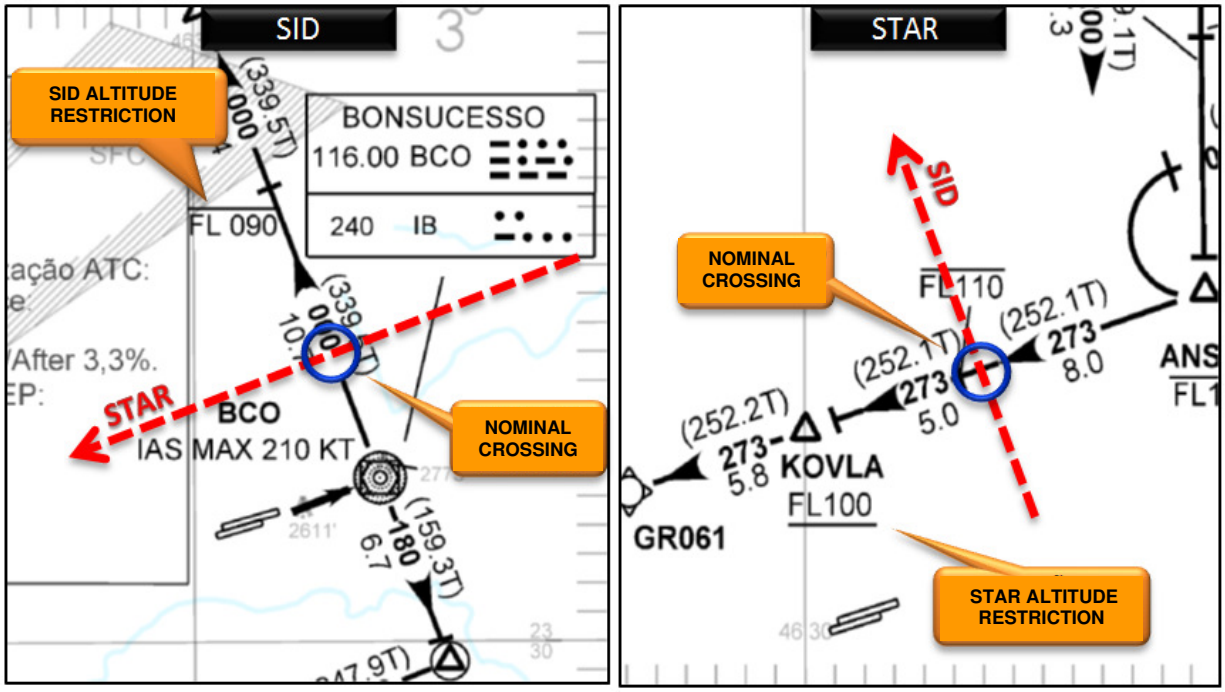

Figure 2 - Crossings between a SID and a STAR from/to the same airdrome – altitude restrictions after nominal crossing.

7.6 The "Four Corner" Concept might not be fully employed to avoid interference between the arrival and departure paths of nearby airports. In this case, the arrival and departure procedures structure can be established so that crossings occur away from the aerodromes involved, although favoring the optimal climb and descent profiles, as appropriate.

8 FLIGHT PLAN FILLING

8.1 The approval status of operators and aircraft relating to any type of RNAV and/or RNP navigation specifications must be indicated in the Filed Flight Plan (FPL), by inserting letter “R” in item 10 of the Flight Plan Form.

8.2 In the specific case of the Repetitive Flight Plan (RPL), the abovementioned approval status must be indicated by inserting the letter “R” in item “Q” of the RPL, as follows: EQPT/R.

8.3 The approval status of each type of air navigation specification must be detailed in item 18 of the FPL or in item “Q” of RPL by inserting the following alphanumeric codes, not exceeding 8 codes, or 16 characters, preceded by the designator PBN/, as indicated in Tables 1 and 2:

Table 1 - RNAV Specifications and Flight Plan Code

CODE	RNAV SPECIFICATIONS
A1	RNAV 10 (RNP 10)
B1	RNAV 5 - All sensors allowed
B2	RNAV 5 GNSS
B3	RNAV 5 DME/DME
B5	RNAV 5 INS ou IRS
C1	RNAV 2 - All sensors allowed
C2	RNAV 2 GNSS
C3	RNAV 2 DME/DME
C4	RNAV 2 DME/DME/IRU
D1	RNAV 1 - All sensors allowed
D2	RNAV 1 GNSS
D3	RNAV 1 DME/DME
D4	RNAV 1 DME/DME/IRU
Note: B4 (RNAV 5 VOR/DME) and B6 (LORAN RNAV 5) Codes are not used in the Brazilian Airspace.	

Table 2 - RNP Specifications and Flight Plan Code

CODE	RNP SPECIFICATIONS
L1	RNP 4
O1	RNP 1 - All sensors allowed
O2	RNP 1 GNSS
O3	RNP 1 DME/DME
O4	RNP 1 DME/DME/IRU
S1	RNP APCH
S2	RNP APCH with BARO-VNAV
T1	RNP AR APCH with RF (special authorization required)
T2	RNP AR APCH without RF (special authorization

9 OPERATIONS OF AIRCRAFT NON-APPROVED FOR RNAV/RNP NAVIGATION SPECIFICATIONS

9.1 Aircraft and operators without approval for RNAV and/or RNP navigation specifications may continue to fly within the Brazilian Airspace, by using "conventional" routes and/or procedures (VOR, VOR/DME, NDB or ILS), or under the radar vectoring used by the ATC units involved in the aircraft operations. However, the ATC units concerned may be required to authorize the operation of such aircraft out of their optimum flight profiles, either by increasing the distance flown or by using altitude restrictions.

10 FINAL ARRANGEMENTS

10.1 DECEA provides a communication channel for you to send questions, suggestions, comments, criticisms, praise and error notifications through the Citizen Service Center at the following address: http://servicos.decea.gov.br/sac/index.cfm, by selecting the CONTATO ("Contact") option in the Área ("Area") menu.

10.2 The other rules remain in force and applicable to the PBN Concept, except for the procedures described in this AIC.

10.3 The criteria and procedures set forth in this AIC does exempt pilots and ATS units from fulfilling the provisions contained in the legislation in force.

10.4 The approval of this AIC was published in DECEA Internal Bulletin nº 204 of 18 of October, 2013.

10.5 Cases not provided for in this Circular shall be settled by the Head of DECEA Operations Subdepartment.