



Agenda Item 2: Follow-up to the implementation status of the performance based navigation systems plans for the CAR and SAM Regions and to the latest amendments to the ATM- and CNS-related SARPS

UPDATED PBN AIRSPACE CONCEPT FOR THE CAR REGION

(Presented by the Secretariat)

EXECUTIVE SUMMARY	
<p>This working paper presents the progress on approach procedures implementation as well as the development of the PBN airspace concept in line with the implementation tasks of the CAR Region.</p>	
<i>ICAO Strategic Objectives:</i>	A: Safety - Enhance global civil aviation safety D: Efficiency - Enhance the efficiency of aviation operations
<i>References:</i>	<ul style="list-style-type: none">• Doc 9854 - <i>Global Air Traffic Management Operational Concept</i>;• Doc 9613 - <i>Performance-based Navigation (PBN) Manual</i>;• Doc 9931 – <i>CDO Manual</i> (advance edition),• Report of the Eighth Central Caribbean Working Group Meeting (C/CAR/WG/8), Miami, USA, 11 to 14 May 2010.• Outcome of the Workshop to Develop a PBN Airspace Concept, ICAO NACC Regional Office, 5 to 7 July 2010

1. Background

1.1 In line with ICAO Assembly Resolution A36/23 and following the guidance of GREPECAS/15 noting the convenience that the planning of PBN tasks be harmoniously developed between the CAR and SAM Regions and recognizing at the same time that the implementation should be carried out in accordance with the operational needs of each Region, the PBN roadmap requires updated adjustments in line with the evolution of the needs of all the States in the CAR Region.

1.2 The PBN workshop conducted in the NACC office from 5 to 7 July 2010, led to many recommendations to be addressed by ICAO and the States/Territories/International Organizations.

2. Analysis

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

2.1 Important operational and economical benefits have derived for the ATS RNAV route implementation programme initiated in 2000 in the CAR/SAM upper airspace as per GREPECAS recommendations. Upon evaluating the operational results of the most direct flight trajectories, as well as the savings in flight distances and time obtained through the implementation of RNAV routes, it can be concluded that the air operators requirements to obtain operational and economical advantages has been satisfied in great measure.

2.2 However, an overall review of the upper airspace is required to identify the possible implementation of new RNAV routes and the elimination of those conventional or RNAV routes of low use, whose trajectory coincides or is similar to the fixed RNAV or random routes considering the traffic increase forecast for the next years, the great demand of direct trajectories outside the airway and the need to avoid complicating the airspace management in the region. In addition, the possible implementation of additional routes could lead to saturation in the various airspaces, which would complicate the airspace management.

2.3 The review of the ATS Route structure is coordinated by the NACC Office and will include implementation of new routes, elimination of others, realignment of conventional or RNAV routes and renaming of other routes based on the analysis of traffic flows and traffic movements, implementation of PBN requirements, operational use of GNSS in order to achieve a comprehensive optimization of the regional ATS route structure. In addition, a CNS infrastructure analysis on the basis of PBN specifications is being achieved to endorse the accommodation of RNAV5 as required by GREPECAS 15 Conclusion 38, as States/Territories/International Organizations are also required to publish PBN regulations and PBN specifications for their current RNAV routes.

Optimization of the ATS routes structure in the terminal airspace

2.4 Considering the current aircraft navigation capacity, and alternatives that allow linking the upper airspace routes structure with the terminal area routes; one solution is the implementation of continuous descent operations (CDO).

2.5 The CDO can include the arrival route of an optimum trajectory calculated by the aircraft flight management computer (FMC) from the initial top of descent point (TOD), or another operationally defined point, up to a point where the approach procedure to the airport is started. With the constant increase of the traffic, the CAR region counts many airports which need to accommodate the CDO concept. The States/Territories/International Organizations of the CAR region are considering implementing CDOs for some airports under their jurisdiction.

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

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

Implementation of PBN approaches

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

2.9 Currently, PBN procedures have been implemented in several airports of the CAR Region. Nevertheless, the general implementation results will be able to be obtained towards the end of 2010, as per the implementation horizon established in the aforementioned Resolution. These implementation tasks are carried out by the States/Territories/International Organizations, as per their own action plan.

PBN Implementation strategy

2.10 Many tasks have been completed, plus there are other implementation tasks which are the responsibility of the States/Territories/International Organizations. Nevertheless, with the aim of optimizing the ATS routes network, the ICAO NACC Regional Office organized a Workshop to Develop a PBN Airspace Concept from 5 to 7 July 2010. The purpose of the Workshop was an overall evaluation of the upper and lower airspace according to ICAO PBN provisions.

2.11 During the workshop, an airspace concept was reviewed as per the PBN Manual, (Doc 9613), with improvements to the RNAV route network, which could be gradually implemented by the CAR States/Territories/COCESNA to improve the airspace organization and management (AOM). The implementation of a PBN airspace concept should be carried out in three phases as follows:

Stage	Operational improvement
Stage I (2010 - 2011)	<u>Review of ATS route network in the CAR Region</u> <ul style="list-style-type: none"> • Gathering data on aircraft PBN capacity • Review CNS infrastructure • Realignment and implementation of new RNAV routes in the upper airspace based on RNAV 5 • Implementation of RNAV routes in the lower airspace based on RNAV 1, RNAV 2 and RNP 1, as required • Implementation of approach procedures PBN APV (BARO-VNAV) in accordance with Assembly Resolution A36-23
Stage II (2011 - 2012)	<u>Review and interface of the ATS routes network in the CAR/SAM Regions</u> <ul style="list-style-type: none"> • Realignment and implementation of new RNAV routes in the interface of the upper airspace between the CAR and SAM Regions, based on RNAV 5 or RNAV 2, as applicable • Implementation of CDO in international airports, as required
Stage III (2012 - 2014)	<ul style="list-style-type: none"> • Elimination of conventional ATS routes in the upper and lower airspace, as required • Implementation of random routes, by airspace altitude stratum • Review of the upper airspace configuration • Review of the lower airspace configuration • Implementation of flexible use of airspace (FUA) • Implementation of dynamic ATS route management

2.12 The implementation of a PBN Airspace Concept supports the NAM/CAR Regional Performance-based Air Navigation Implementation Plan (NAM/CAR RPBANIP) approved by the NACC/DCA/3, the PBN Manual, Doc 9613, and the ATM Operational Concept, Doc 9854.

2.13 The preparation of the PBN airspace concept, included in the **Appendix** to this Working Paper, is also foreseen in all the subregional working groups action plan to improve ATS route and airspace network as a comprehensive implementation approach.

3. Suggested Action

3.1 The Meeting is invited to:

- a) support the development of a PBN airspace concept for the CAR Region; and
- b) take other actions as deemed pertinent to ensure timely PBN implementation.

APPENDIX PBN AIRSPACE CONCEPT FOR THE CAR REGION

INTRODUCTION

1 The CAR Region airspace will be organized and managed in a manner that will accommodate all current and envisioned users of the airspace, *inter alia*, civil and military aircraft, unmanned aircraft systems and transiting spacecraft.

2 The implementation of the PBN Airspace Concept is supported by the ICAO Global ATM Operational Concept (Doc 9854), PBN Manual (Doc 9613), and the Regional Performance-based Air Navigation Implementation Plan (NAM/CAR RPB ANIP) for the NAM/CAR Regions.

3 PBN airspace concept will allow direct improvements to the airspace organization and management (AOM) and on other implementation activities such as improvements in ATM situational awareness, airspace and airport demand and capacity balancing (DCB), airport operations (AO), provision of meteorological information and publication of information in the AIP, etc.

4 Efficient airspace management will enhance the capacity of the air navigation service provider (ANSP) and will increase ATM system safety, capacity and efficiency in benefit to the ATM community. Environmental protection benefits will be periodically measured against implementation achievements.

5 Implementation of a PBN Airspace Concept in the CAR Region is consistent with the ICAO strategic objectives, as follows:

Safety

Implementation of a PBN Airspace Concept will facilitate the harmonization and interoperability of procedures and air operations among the ATS airspace.

The implementation of Continuous Descent Operations (CDO) and approach procedures with vertical guidance APV (Baro-VNAV) and/or RNP AR, through stabilized approaches, will reduce the risk of Controlled Flight into Terrain (CFIT).

Capacity

Implementation of a PBN Airspace Concept will allow the reduction of spacing between aircraft and the use of ATC vector guidance in departure and arrival routes, which will result in a reduction of airspace complexity and of ATC workload. The final goal effect will be an increment in ATS airspace capacity.

Efficiency

Implementation of a PBN Airspace Concept will allow aircraft operations on optimum tracks from the en-route phase to final approach and from departure to the selected route. Efficiency will also be reflected in the publication of better climb and descent profiles in gate-to-gate operations with more flexible tracks to increase operational efficiency, while reducing fuel consumption.

The Global Air Traffic Management (ATM) Operational Concept

6 The global ATM operational concept presents the ICAO vision for an integrated, harmonized and globally interoperable, ATM system. The planning horizon is up to and beyond the year 2025.

Vision Statement

To achieve an interoperable global air traffic management system, for all users during all phases of flight, that meets agreed levels of safety, provides for optimum economic operations, is environmentally sustainable and meets national security requirements.

Homogeneous ATM Area

7 A homogeneous ATM area is defined as airspace with a common ATM interest based on similar characteristics of traffic density, complexity, air navigation infrastructure requirements or other specified considerations, wherein a common detailed plan fosters the implementation of interoperable air navigation systems. The essential elements to be considered when establishing a homogeneous ATM area should be the technical and operational requirements.

8 Homogeneous ATM areas may extend over States, specified portions of States or groupings of States. They may also extend over large oceanic and/or continental en-route areas.

Major Traffic Flow

9 A major traffic flow is defined as a concentration of significant volumes of air traffic on the same or proximate flight trajectories. Major traffic flows may cross several homogeneous ATM areas with different characteristics. A *routing area* is a defined area encompassing one or more major traffic flows.

10 A routing area may include groupings of routes, or area navigation (RNAV) areas, wherein is a specific detailed plan for the implementation of an ATM system; the objective is to attain a seamless system.

11 Major traffic flows and routing areas are defined by origin and destination geographic areas, which could be States, specific portions of States or groupings of smaller States. This may include oceanic and continental en-route areas.

Planning Based on Homogeneous ATM Areas and Major Traffic Flows

12 The basic planning parameter in establishing a homogeneous ATM area or major traffic flow is the number of aircraft movements that must be provided with ATM services in an area or along a flow. Estimates and forecasts of annual aircraft movements are required for high-level planning. Forecasts of aircraft movements in peak periods, such as during a particularly busy hour, are needed for detailed planning.

13 The CAR Region is a homogeneous ATM area with routes extending into the adjacent NAM and SAM Regions. Transition air operations between areas and regions will be transparent to users.

Implementation of PBN Airspace Concept

14 Having a very strategic geographical location at the confluence of ATS routes connecting the major destinations, Caribbean airspace has become a vital link to the flow of traffic between NAM and SAM Regions.

15 Traditionally, air navigation depended mostly on ground-based navaids with inherent limitations that prevent the seamlessness and flexibility required for efficient air operations, specifically in the vicinity of airports with complex topography.

16 Performance-based navigation, comprising area navigation (RNAV) and required navigation performance (RNP), solves these limitations using existing aircraft navigation capabilities.

17 PBN specifies the navigation performance requirements necessary to operate on an ATS route, an instrument approach procedure or in a particular airspace.

18 Based on the assessment of the navigation infrastructure in the CAR airspace, the navaids network coverage, ground and satellite based, as well as radar coverage and communications coverage allow the implementation of RNAV 5, RNAV 2, RNAV 1 navigation specifications, as required. It has been identified that the central oceanic area of the Gulf of Mexico and the oceanic area between the Curacao, Dominican Republic and Jamaica FIRs require surveillance systems (ADS) or CPDLC for RNP implementation.

19 The comprehensive implementation of the PBN airspace concept will harmonize navigation specifications for all phases of flight on oceanic and continental en-route areas, terminal area and approach segments, and will harmonize ATS route network between NAM, CAR and SAM Regions with the objective of achieving a single airspace continuum. The application of navigation specification by flight phase is determined by the following table:

Navigation Specification	Flight Phase							
	En Route Oceanic / Remote	En Route Continental	ARR	APPROACH				DEP
				Initial	Interm.	Final	Missed	
RNAV/RNP 10	10							
RNAV 5		5	5					
RNAV 2		2	2					2
RNAV 1		1	1	1	1		1 ^b	1
RNP 4	4							
Basic RNP 1			1 ^{a,c}	1 ^a	1 ^a		1 ^{ab}	1 ^{a,c}
RNP APCH				1	1	0.3	1	
RNP AR APCH				1-0.1	1-0.1	0.3-0.1	1-0.1	

Notes:

- The numbers given in the table refer to the 95 per cent accuracy requirements (NM).
- RNAV 5 is an en-route specification which may be used for the initial part of the STAR outside 30 NM and above the minimum sector altitude.
- 1^a The navigation application is limited to use on standard instrument arrivals (STARs) and standard instrument departures (SIDs) only.
- 1^b The area of application can only be used after the initial climb of a missed approach phase.

- 1^o Beyond 30 NM from the airport reference point (ARP), the accuracy value for alerting becomes 2 NM.

20 The application of the PBN airspace concept is for the following 14 flight information regions (FIRs) of CAR Region:

Central American, Curaçao, Habana, Houston Oceanic, Kingston, Mazatlan Oceanic, Mexico, Miami Oceanic, Nassau, New York Oceanic, Piarco, Port-au-Prince, San Juan, and Santo Domingo.

21 The implementation of the PBN airspace concept includes users operations through flight management computer (FMC) applications, the comprehensive review of the lower and upper airspace, as well as the implementation of continuous descent operations (CDO) and RNAV/RNP approach procedures, in compliance with ICAO guidelines.

Airspace user operations

22 Airspace user operations refer to the airspace-related aspects of flight operations, as follows:

- a) the users' needs and aircraft navigation capabilities will be identified in order to enhance safety and efficiency;
- b) relevant ATM data will be made available for the airspace user's tactical and strategic situational awareness and conflict management;
- c) relevant airspace users operational information will be available to the ANSP to enhance tactical and strategic situational awareness and conflict management; and
- d) collaborative decision-making will be encouraged to ensure that users expectations and aircraft capabilities will be taken into account when designing the airspace.

Airspace organization and management (AOM)

23 All airspace will be a usable resource. The organization, allocation and flexible use of airspace will be based on the principles of access and equity. Airspace organization should be in accordance with the ICAO airspace classification.

24 The airspace organization function will provide the strategies, rules and procedures by which the airspace will be structured to accommodate different types of operations, volume of traffic, and differing levels of service and rules of conduct.

25 The principles of organization will be applicable from high traffic density to low traffic density. The organizational principles include the following:

- a) airspace should be organized so as to be easily learned, understood and used by the ATM community;
- b) airspace organizational boundaries and divisions should be adjusted to accommodate particular traffic flows and should not be constrained by national or facility boundaries;
- c) airspace should be organized to facilitate seamless operations of flights and the ability to conduct flights along optimum flight trajectories from gate-to-gate eliminating all restrictions or delays as possible;
- d) airspace design should consider ATS route systems and dynamic trajectories that enable aircraft to operate along to their preferred flight paths, or as near as practicable; and
- e) Airspace management should be dynamic, flexible and based on user preferred services.

26 Airspace organization will be based on the principle that all airspace is managed to meet the needs of the ATM community. “Managed” means that a strategic or tactical decision regarding the level of service to be provided will be taken by the appropriate authority and/or ANSP. Airspace management will consider dynamic procedures and sectorization in benefit to air operations.

27 Air navigation service providers in charge of managing airspace will be able to make tactical modifications to specific parts of airspace to respond in real-time to changing situations in traffic patterns and/or runway(s) in use, according to operational needs.

28 The dynamic configurations of airspace will be established according to the forecasted traffic flows in order to optimize dynamically users preferred paths, based on statistical data. Airspace management will consider the application of dynamic procedures and sectorization through flexible routes (parallel and/or perpendicular) in accordance with the operational requirements, for the benefit of air operations.

29 To achieve a dynamic airspace management, said should be analysed, to facilitate the tactical application of one or a combination of the following actions:

- a) From the minimum en route altitude (MEA) until FL190, aircraft operations will be allowed using the published RNAV route network;
- b) At or above FL200, throughout the continental or oceanic airspace, airspace operations will be allowed:
 - i) in random RNAV routes, or;
 - ii) in the regional and/or national fixed RNAV route network ;

- c) Long haul flights or flights at or above FL360 should be facilitated to operate in random RNAV routes based on the foreseen traffic flow, wherever possible.

30 Air traffic management at aerodromes should facilitate optimized RNAV or RNP routes in all weather operations, also complying with obstacle clearance and environment protection requirements. The appropriate authority and/or ANSPs should ensure to diffuse in a timely manner the applicable standards and procedures in the different classes of airspace.

31 There should be no permanent/fixed constrained airspace or during an extended period; airspace should only be subjected to service limitations, national interests or safety issues. All airspace constraints should be properly coordinated with the ATM community. Additionally, for a complete dynamic airspace management implementation of efficient civil/military coordination is required so as to achieve flexible use of airspace (FUA).

32 Airspace should not be organized in a manner that permanently precludes the possibility of mixed usage/mixed equipage operations. Priority for the use of specific airspace should not be constrained by equipage usage.

Optimization of the ATS route structure in en-route airspace

33 To date, many RNAV routes have been implemented in the upper CAR/SAM airspace, as per GREPECAS recommendations, plus many additional routes which had not been foreseen. These implementations have been carried out by identifying the needs of the users, operators and ANSPs. The implementation programmes have generated important operational and economical benefits.

34 Upon evaluating the operational results of the most direct flight trajectories, as well as the savings in flight distances and time obtained through the implementation of RNAV routes, it can be concluded that the operators' requirements to obtain operational and economical advantages have been satisfied in great measure. Consistent with the benefits obtained, the need for additional RNAV routes has been identified.

35 The regionally agreed decommissioning of NDBs combined with forecast traffic growth, the increasing demand for direct trajectories outside conventional airways and the possible implementation of additional RNAV routes could lead to saturation in various airspaces, further complicating airspace management.

36 Therefore, an overall review of the upper airspace should be conducted considering the possible implementation of new RNAV routes and the removal of those rarely used conventional routes whose trajectories coincide with or are similar to fixed RNAV or random routes.

Optimization of the ATS route structure in terminal airspace

37 GREPECAS recommended the implementation of trunk routes to link the upper airspace RNAV routes with the arrival and departure routes implemented in terminal areas. Standard instrument arrivals (STARs) and standard instrument departures (SIDs) should be designed to connect directly to the upper airspace ATS route network in order to enhance airspace management and provide more consistent flight paths and stabilized approach paths while reducing pilot and ATC workload, radio-frequency transmissions, fuel consumption and incidence of controlled flight into terrain (CFIT).

38 SIDs and STARs have been implemented and improved in the terminal areas of international airports of many CAR States. Nevertheless, considering the current aircraft navigation capability, it is appropriate to consider extending these procedures, linking the upper airspace route structure directly with the terminal area routes.

39 The soon-to-be-published *Continuous Descent Manual*, Doc 9931, urges States to consider implementation of continuous descent operations (CDO) on all STARs, starting from top of descent in the upper airspace. To this end, STARs should be designed such that they connect directly from the en-route RNAV or conventional routes to the instrument approach procedure.

40 A CDO allows an optimum profile descent on the published arrival route, calculated by the aircraft's flight management computer (FMS) from the initial top-of-descent point (TOD), or other operationally defined point, to the point where the approach procedure to the runway is commenced.

41 The CDO concept permits ATC to adjust an aircraft's arrival trajectory and speed if necessary to maintain separation and sequencing from other aircraft while providing a substantial operational improvement, and reducing workload of both pilots and controllers. The CDO also maximizes the advantages for each flight in terms of reduced fuel consumption, gaseous emissions and noise, as well as better forecasting possibilities for the flight crew and the aircraft operator.

42 Continuous descent operations are enabled by airspace design, procedure design and ATC facilitation, allows the aircraft to descend continuously employing minimum engine thrust in a low drag configuration. CDO is potentially usable by 85% of the aircraft, 85% of the flight time of descent.

43 The implementation of CDOs entails a review of the organization of upper and lower airspace and consequential improvements to air traffic management in order to determine where operational advantages can be obtained. The following are international airports where CDOs could be implemented:

BARBADOS

TBPB BRIDGETOWN /Grantley Adams Intl.

COSTA RICA

MROC ALAJUELA /Juan Santamaría Intl.

GRAND CAYMAN

MWCG /Roberts International Airport

CUBA

MUHA HABANA /José Martí

DOMINICAN REPUBLIC

MDPC PUNTA CANA INTERNATIONAL AIRPORT

EL SALVADOR

MSLP SAN SALVADOR / EL SALVADOR Intl.

GUATEMALA

MGGT GUATEMALA /La Aurora

HONDURAS*MHTG TEGUCIGALPA /Toncontin Intl.*JAMAICA*MKJP KINGSTON / Norman Manley Intl.*MEXICO*MMUN CANCUN /Cancún Intl.**MMGL GUADALAJARA /Miguel Hidalgo Costilla Intl.**MMM MEXICO /Lic. Benito Juárez Intl.**MMMY MONTERREY /Gral. Mariano Escobedo Intl.**MMPR PUERTO VALLARTA /Lic. Gustavo Díaz Ordaz Intl.**MMSD SAN JOSE DEL CABO /San José del Cabo Intl.**MMTO TOLUCA /Lic. Adolfo López Mateos Intl.*PUERTO RICO*TJSJ SAN JUAN /Luis Muñoz Marín Intl.*TRINIDAD AND TOBAGO*TTPP PORT OF SPAIN /Piarco Intl. Trinidad I.*

44 Continuous Climb Operations (CCO) will provide States and other stakeholders with pragmatic guidance on how to implement CCOs for aircraft climbing continuously, ideally to cruise level.

Implementation of PBN Approach Procedures

45 According to ICAO Assembly Resolution A36/23, States should implement approach procedures with vertical guidance (APV) to all runway ends serving aircraft with a maximum certificated take-off mass of 5700 kg or more, to achieve the following:

- i) implementation of RNAV and RNP operations (where required) for en route and terminal areas according to established timelines and intermediate milestones; and
- ii) implementation of approach procedures with vertical guidance (APV) (Baro-VNAV and/or augmented GNSS) for all instrument runway ends, either as the primary approach or as a back-up for precision approaches by 2016 with intermediate milestones as follows: 30 per cent by 2010 and 70 per cent by 2014.

Implementation Phases

46 The implementation of PBN Airspace Concept should be in three phases as follows:

Stage	Operational improvement
Stage I (2010 2011)	<u>Review of ATS route network in the CAR Region</u> <ul style="list-style-type: none"> • Gathering data on aircraft PBN capacity • Review of CNS infrastructure • Realignment and implementation of new RNAV routes in the upper airspace based on RNAV 5 • Implementation of RNAV routes in the lower airspace based on RNAV 1, RNAV 2 and RNP 1, as required • Implementation of approach procedures PBN APV (BARO-VNAV in accordance with Assembly Resolution A36-23)
Stage II (2011 2012)	<u>Review and interface of the ATS routes network in the CAR/SAM Regions</u> <ul style="list-style-type: none"> • Realignment and implementation of new RNAV routes in the interface of the upper airspace between the CAR and SAM Regions, based on RNAV 5 or RNAV 2, as applicable • Implementation of CDO in international airports, as required
Stage III (2012 2014)	<ul style="list-style-type: none"> • Elimination of conventional ATS routes in the upper and lower airspace, as required • Implementation of random routes, by airspace altitude stratum • Review of the upper airspace configuration • Review of the lower airspace configuration • Implementation of flexible use of airspace (FUA) • Implementation of dynamic ATS route management

47 In each phase, the air traffic management procedures and Letters of Agreement between ATS units will be reviewed accordingly, as applicable.

48 States, Territories and ANSPs concerned should develop their action plans towards implementation of regional PBN airspace concept. National implementation plans will describe the progressive steps according to the PBN regional goals.

49 Appendix B to WP/28 provides diagrams on:

- proposal of PBN routes for implementation in the upper airspace of the CAR Region;
- proposal of PBN routes for analysis and implementation in the CAR/SAM upper airspace;
- a model CDO descent profile; and
- a model PBN AR approach procedure.

Safety Assessment

50 Safety assessment can be either qualitative or quantitative, under the responsibility of ANSPs in coordination with the States aeronautical authority. The following table shows the references for safety assessment prior to PBN implementation:

Navigation specification	Safety assessment references
RNAV/RNP 10	1) Regional Supplementary Procedures (Doc 7030) 2) Manual on Airspace Planning Methodology for the Determination of Separation Minima (Doc 9689) 3) Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM) (Doc 4444)
RNAV 5	EUROCONTROL B-RNAV route spacing study European Region Area Navigation (RNAV) Guidance Material (ICAO EUR Doc 001, RNAV/5)
RNAV – RNP 2	<i>TBD</i>
RNAV 1	EUROCONTROL safety assessment of PRNAV route spacing and aircraft separation
RNP 4	1) Regional Supplementary Procedures (Doc 7030) 2) Manual on Airspace Planning Methodology for the Determination of Separation Minima (Doc 9689) 3) Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM) (Doc 4444)
BASIC RNP 1	Procedures for Air Navigation Services — Aircraft Operations (PANS-OPS) (Doc 8168), Volume II
Advanced-RNP 1	<i>TBD</i>
RNP APCH	Procedures for Air Navigation Services — Aircraft Operations (PANS-OPS) (Doc 8168), Volume II
RNP AR APCH	Required Navigation Performance Authorization Required (RNP AR) Procedure Design Manual (Doc 9905)

51 A monitoring programme should be established to assess safety after PBN implementation through performance data analysis, as set forth in ICAO *Safety Management Manual (SMM)* (Doc 9859).