ICAO

International Civil Aviation Organization
North American, Central American and Caribbean Office

Regional Technical Cooperation Project for the
Multi-Regional Civil Aviation Assistance Programme
(MCAAP) (RLA/09/801)

Sub-Project to Develop and Implement a Performance-Based Navigation (PBN) Airspace Concept Document for the CAR Region

Phase 1 Report

Prepared by

Jorge Centella Artola, Cuba
Alexi Manuel Batista Ruiz, Dominican Republic
William Alsina, Dominican Republic
Riaaz Mohammed, Trinidad and Tobago
César Turcios Valiente, COCESNA
Eddian Méndez, ICAO

August 2018

Contents

1. General

Place of Initial Meeting:	ICAO NACC Regional Office Mexico City, Mexico
Dates of Initial Meeting:	8 to 11 May 2018
Team Composition:	Jorge Centella Artola, Cuba Alexi Manuel Batista Ruiz, Dominican Republic William Alsina, Dominican Republic Riaaz Mohammed, Trinidad and Tobago César Turcios Valiente, COCESNA
ICAO Representative:	Eddian Méndez Regional Officer, Air Traffic Management and Search and Rescue
Objectives of the Mission:	● Develop a model structure for airspace and Terminal Areas (TMAs) that allows continuous flow in the upper and lower airspace of contiguous Flight Information Regions (FIRs) and TMAs, proposing a possible solution to the complex structure of the existing FIRs in the CAR Region.
Summary of Activities:	● Initial meeting with the Subject Matter Experts (SMEs) to discuss the sub-project mission objectives ● Assessment of information for regional PBN implementation, as appropriate ● Review information regarding FIR and TMA requirements for the CAR Region, and make an assessment of implementation in accordance with the NAM/CAR Regional Performance-Based Air Navigation Implementation Plan (RPBANIP) and Air Navigation Plan ● Draft a report summarizing the sub-project mission outcomes.

2. Introduction

2.1 PBN implementation is a living concept. Even though PBN regional implementation targets may or may not have been met, States and International Organizations need to work to comply with agreed objectives and continue improvement to allow an efficient flow of the increasing traffic.

2.2 The composition of the Caribbean (CAR) Region is very heterogeneous with different scenarios between adjacent States, with radar and non-radar environments, oceanic and continental airspaces, high density and moderate flows of traffic, different infrastructure and technologies amongst States, and other factors, reflected in this document, that create a challenge to harmonize the PBN implementation plans of the States and International Organizations within.

2.3 Despite the differences and challenges within the region, it is imperative to develop a harmonized approach to PBN implementation. This Sub-Project, led by the ICAO NACC Regional Office and consisting of Subject Matter Experts (SMEs) selected from among Project Member States, was formed with the objective to develop a model concept for airspace and Terminal Areas (TMAs) that allows continuous flow in the upper and lower airspace of contiguous Flight Information Regions (FIRs) and TMAs, proposing a possible solution to the complex structure of the existing FIRs in the CAR Region.

2.4 The model concept developed provides the minimum requirements that each State or International Organization should consider in developing its individual PBN implementation plan. It also provides an analysis of PBN implementation within the region; documents reported challenges and aims to provide recommendations to assist those States/International Organizations which are currently encountering difficulties in meeting PBN implementation objectives.

3. Objectives

3.1 The goal of ICAO is to ensure that no State is left behind. While it is understood that growth rates amongst individual States and International Organizations may differ based on various factors, it is important to ensure that there is a mechanism which allow all States and International Organizations to meet at least the minimum targets established for safety and efficiency within the region.

3.2 The main objective of this document is to ensure a balanced PBN implementation within the CAR Region which enhances the interoperability of air navigation services throughout the entire airspace. States with difficulty in the implementation can review the information in this document to determine what is required to develop an efficient and safe airspace structure and also what kind of assistance they need to acquire.

3.3 It is expected that with a harmonized approach to PBN implementation within the region, the following benefits will be derived:

- Assistance for States to comply with Aviation System Block Upgrade (ASBU) Block Zero airspace optimization requirements
- Assistance to meet and comply with Regional Performance Objectives (RPOs) within the ICAO NACC Regional Performance Based Air Navigation Implementation Plan (RPBANIP)
- Achieve increased homogeneity in the airspace between adjacent States
- Reduction of distance travelled from point to point for each aircraft operation
- Improvement in aircraft fuel savings and reduction of CO_2 emissions
- Optimizations of continuous climb and descend profiles for aircraft
- Reduction of the use of holding patterns
- Greater access through mountainous areas
- Reduction of noise in the vicinity of airports
- Reduction of pilot and Air Traffic Controllers (ATCOs) workload
- Reduction in occupancy of telecommunications frequencies
- Reduction in the need to purchase and maintain ground based navigational aids
- Less proximity alerts based on the terrain
- Increased flexible use of airspace

4. Scope

4.1 In reviewing the Terms of Reference of the Sub-Project, the SMEs in collaboration with the ICAO NACC Regional Officer ATM/SAR, determined that based on the diversity of the individual CAR State's/Organization's airspace and also on the limited information available to the project team, it would be more productive to carry out the project on the following three phases:

1. **Phase 1 – Concept Development**
   In this phase the minimum requirements for upper and lower airspaces of the CAR Region are defined. The model concept is presented as a report for the subproject.

2. **Phase 2 – Data collection and analysis**
   The purpose of this phase is to collect evidence regarding the PBN implementation status for each upper and lower airspace and the airspace optimization capabilities for each State and International Organization of the CAR Region.

3. **Phase 3 – Assessment and development of individual plans**
   After detailed information regarding the implementation and capacities of States and International Organizations has been reviewed, an objective assessment of the situation is performed and individual plans to close the detected gaps are developed. Here will be also identified the assistance required and possible collaboration with other stakeholders.

4.2 The model concept is developed to ensure understanding amongst all States and International Organizations of the minimum requirements needed for an adequate and harmonized approach to PBN implementation within the CAR Region. This concept is intended to be applied in the airspaces of the CAR Region, detailed in **Appendix A** to this report.

4.3 Phases 2 and 3 should be carried out by the ICAO NACC Regional Office, supported by the ANI/WG PBN Task Force, following the guidelines provided by the Sub-Project.

4.4 While it is understood that United States is in the process of developing an airspace plan for the Miami Oceanic, Houston Oceanic and New York Oceanic FIRs, due to the high flow of traffic, and airspace complexity, a PBN point of contact from the FAA is required; For specific details regarding routes implementation, it is also recommended to identify points of contact for each of United States´ aforementioned FIRs, to coordinate with the adjacent CAR State/Organization representatives.

5. Methodology Employed by the Project Team

5.1 **Phase 1** – Concept Development

The Project Team reviewed the PBN RPO stated within the RPBANIP and determined a list of minimum requirements for each airspace that each State/Organization should be engaged in to ensure an adequate level of airspace harmonization within the CAR Region.

The team also reviewed previous reports provided by the ANI/WG PBN Task Force at past Working Group meetings and the airspace harmonization meetings and discussed common challenges faced by most of the States/International Organizations.

As part of the process, the SMEs provided information relating to PBN implementation in their respective State/Organization, and discussed best practices employed in PBN implementation planning.

The Team developed generic templates of work programmes for development of RNAV 5 routes and SIDs and STARs which are included within the document as **Appendixes B and C**.

As part of the review, the Team recognized the fact the target dates specified in the RPBANIP had elapsed, and recommends that a review of target dates be considered during the ANI/WG/4 meeting.

5.2 **Phase 2** – Data collection and analysis

The Team created a form aimed at capturing information relating to the PBN implementation status of Individual States and Organizations within the CAR Region. A State letter will be sent by the ICAO NACC Regional Office, requesting that all

States/International Organizations complete the form and return it to the ICAO NACC Regional Office.

Each State/International Organization will be required to designate a representative capable of coordinating with the ICAO NACC Regional Office and the Team.

The information collected will be entered into a database within the ICAO NACC Regional Office and will be used by the Team to analyse the status of each State/Organization.

Apart from creating an individual profile for each State/Organization, the Team will also update the list of common challenges and provide recommendations for their mitigation.

During Phase 1 of this project, the Team collected and analysed data from the following States/Organization:

- Cuba – upper/lower airspace
- Dominican Republic - upper/lower airspace
- Trinidad and Tobago - upper/lower airspace for TTPP. (Awaiting further information from Eastern Caribbean States)
- COCESNA – upper airspace (Some information provided for lower airspace. Awaiting further information from Central American States)

5.3 **Phase 3** – Assessment and development of individual plans

On completion of Phase 2, the Team will provide specific recommendations to each State/Organization based on the profiles created.

Additionally, the Team will identify both strengths and weaknesses of individual States/International Organizations and will provide recommendations to the ICAO NACC Regional Office regarding the best use of available resources within the region. The ICAO NACC Regional Office will seek the support of those States/International Organizations who are capable of providing assistance to any other State/Organization that may require it.

5.4 The table below shows the tasks and projected timelines for each phase.

Phase	Task	Responsible	Start	End	Status
1	Review of PBN RPOs	Project Team	8 May 2018	8 May 2018	Completed
	Determine list of minimum requirements for all airspaces (upper/lower	Project Team	8 May, 2018	9 May 2018	Completed

Phase	Task	Responsible	Start	End	Status
	airspace)				
	Review previous reports of ANI/WG PBN Task Force	Project Team	9 May 2018	9 May 2018	Completed
	List common challenges faced by States/International Organizations in PBN Implementation	Project Team	9 May 2018	9 May, 2018	Completed
	SMEs provide information on best practices within their States/International Organizations	Project Team	10 May 2018	10 May 2018	Completed
	Develop form to collect data from States/Organization	Project Team	10 May 2018	10 May 2018	Completed
	SMEs provide information on their respective States'/Organization's PBN implementation status	Project Team	10 May 2018	11 May 2018	Completed
	Develop Template for development of PBN SIDs and STARs as well as RNAV 5 routes	Project Team	11 May 2018	11 May 2015	Completed
	Produce report on Phase 1 Project	Project Team	11 May 2018	30 June 2018	Completed
2	ICAO NACC Regional Office to promulgate State letter to each State/Organization	ICAO NACC Regional Office	28 August 2018	3 September 2018	
	Each State/Territory to complete and submit the form to the ICAO NACC Regional Office	States/Territories	3 September 2018	3 October, 2018	
	Create database of responses	ICAO NACC Regional Office	15 October 2018	30 November 2018	
	Analysis of State/Organization responses	Project Team	3 December 2018	7 December 2018	
	Create profile on each	Project Team in	10	14 December	

Phase	Task	Responsible	Start	End	Status
	State/Organization	consultation with respective State/Organization	December 2018	2018	
	Update list of common PBN implementation challenges	Project Team	10 December 2018	14 December 2018	
3	Provide each State/Organization with an assessment of their implementation, including recommendations	Project Team through the ICAO NACC Regional Office	14 January 2018	18 January 2018	
	Provide recommendations to the ICAO NACC Regional Office on best use of resources within the Region	Project Team	14 January 2018	18 January 2018	

6. Model Concept for PBN Harmonization within the CAR Region

6.1 General

6.1.1 The model concept is based on the minimum requirements considered to accommodate all current and envisioned users of the airspace providing safety, capacity and efficiency of operations in a PBN environment.

6.1.2 The model concept is divided in requirements for upper and lower airspace, to facilitate States the verification of accomplishment for every airspace structure.

6.2. Minimum Requirements for the Upper Airspace

6.2.1 The minimum requirements for the upper airspace consider as listed in the following table:

	Minimum Requirements
Upper Airspace	Implementation of RNAV 5 routes as agreed to in the Regional Air Navigation Plan
	Removal of conventional routes made redundant by PBN route implementation
	Implementation of RNAV 1/2 STAR/SIDs (CCOs and CDOs) to TMAs within the FIR

	Minimum Requirements
	Implementation of 20NM longitudinal separation at FIR boundaries (where applicable)
	All routes and waypoints published by the States are correctly processed through the ICAO International Codes and Route Designators (ICARD) database
	Oceanic airspace lateral separation (where applicable)

6.3 Description of the minimum requirements for the upper airspace

6.3.1 Implementation of RNAV 5 routes as agreed to in the Regional ANP

6.3.1.1 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 or a combination of the following types of position sensors, together with the means to establish and follow a desired path: a) VOR/DME; b) DME/DME; c) INS or IRS; and d) GNSS.

6.3.1.2 The air navigation service providers (ANSP) must assess the navaid infrastructure in order to ensure that it is sufficient for the proposed operations, including reversionary modes. It is acceptable for gaps in navaid coverage to be present; when this occurs, route spacing and obstacle clearance surfaces need to take account of the expected increase in lateral track-keeping errors during the "dead reckoning" phase of flight.

6.3.1.3 Regarding separation, in an ATC surveillance environment, the route spacing will depend on acceptable ATC workload and availability of controller tools, separation is considered as follows:

- 16.5 NM for same-direction traffic
- 18 NM for opposite-direction traffic
- As low as 10 NM where ATC intervention capability permits.

6.3.2 Removal of conventional routes made redundant by PBN route implementation.

6.3.2.1 RNAV/RNP routes are more efficient than conventional routes providing "gate to gate" operations and also do not rely on radio aids installed on ground, improving safety and accuracy. These are the main reasons why it is considered important to make redundant and replace conventional routes to RNAV/RNP routes.

6.3.3 **Implementation of RNAV 1/2 STAR/SIDs (CCOs and CDOs) to TMAs within the FIR**

6.3.3.1 The main objective is to improve safety, predictability of flights and airspace capacity while reducing noise, fuel consumption, CO_2 emissions and pilot-controller communications at the same time.

6.3.3.2 Continuous Descent Operation (CDO) is an aircraft operating technique aided by appropriate airspace and procedure design and appropriate ATC clearances enabling the execution of a flight profile optimized to the operating capability of the aircraft, with low engine thrust settings and, where possible, a low drag configuration, thereby reducing fuel burn and emissions during descent. The optimum vertical profile takes the form of a continuously descending path, with a minimum of level flight segments only as needed to decelerate and configure the aircraft or to establish on a landing guidance system (e.g. ILS).

6.3.3.3 Continuous Climb Operation (CCO) is an aircraft operating technique enabled by airspace design, instrument procedure design and facilitation by ATC, allowing for the execution of a flight profile optimized to the performance of the aircraft. CCO enables the aircraft to attain initial cruise flight level at optimum airspeed and engine thrust settings set throughout the climb, thereby reducing total fuel burn and emissions. Ideally, the departure design is such that arriving traffic is also able to descend based on an optimum descent profile. Where the departure and arrival flows cannot be designed independently, there will need to be a compromise between the needs of the departure and arrival flow optimization; this compromise should be reached collaboratively.

6.3.3.4 An aircraft's fuel efficiency in terms of fuel burned per kilometre flown in levelled flight increases with height. However, the fuel used in climbing to that altitude can be a significant part of the overall fuel used for the flight. Therefore, for any given route length, there is an optimum initial cruise flight level which will be dependent upon the aircraft type and mass, as well as on the meteorological conditions of the day. CCO is only one of the tools involved in a complete airspace design. Throughout the design process, CDO, CCO and other route modifications should all be considered.

6.3.4 Implementation of 20 NM longitudinal separation at FIR Boundaries (*where applicable*).

6.3.4.1 This requirement is based on the longitudinal separation minima based on distance using Distance Measuring Equipment (DME) and/or GNSS.

6.3.4.2 Separation shall be established by maintaining not less than specified distance(s) between aircraft positions as reported by reference to DME in conjunction with other appropriate navigation aids and/or GNSS. This type of separation shall be applied between two aircraft using DME, or two aircraft using GNSS, or one aircraft using DME and one aircraft using GNSS. Direct controller-pilot VHF voice communication shall be maintained while such separation is used.

6.3.5 All routes and waypoints published by the States in their AIP, are correctly processed through the ICAO International Codes and Route Designators (ICARD) database.

6.3.5.1 States/International Organizations are requested to submit and maintain up to date ICAO ICARD database with the new and previous routes and waypoints in order to eliminate codes

duplication and differences between the geographical coordinates of waypoints published in the AIP and those feed it in the ICARD.

6.3.5.2 States/International Organizations are also requested to make coordination with neighbouring FIRs to publish in the respective AIP the same coordinates for the Transfer of Control Points (TCP).

6.3.6 For oceanic airspace, use of 50 NM lateral separation.

6.3.6.1 RNAV 10 (designated and authorized as RNP 10) supports 50 NM lateral and 50 NM longitudinal distance based separation minima in oceanic or remote area airspace.

6.3.6.2 States/International Organizations shall comply with this separation in order to maintain a safety flow of traffic and a separation harmonization with all FIRs of the CAR Region.

6.3.7 For oceanic airspace, use of 30 NM longitudinal and lateral separation.

6.3.7.1 RNP 4 supports 30 NM lateral and the 30 NM longitudinal distance based separation minima in oceanic or remote area airspace.

6.3.7.2 States/International Organizations shall comply with this separation in order to maintain a safety flow of traffic and a separation harmonization with all FIR of the CAR Region.

6.4. Minimum Requirements for the Lower Airspace

6.4.1 The minimum requirements for the lower airspace considered are listed in the following table:

	Minimum Requirements
Lower Airspace	Implementation of RNAV 1/2 STAR/SIDs(CCOs and CDOs) to TMAs within the FIR
	Implementation of at least LNAV approaches for International Airports
	LNAV/VNAV (BARO VNAV) Approaches if analysis determines a benefit
	Implementation of RNP AR Approaches if analysis determines a benefit
	Implementation of APV (GBAS) Approaches if analysis determines a benefit

6.5 Description of the requirements for the lower airspace

6.5.1 Implementation of RNAV 1/2 STAR/SIDs (CCOs and CDOs) to TMAs within the FIR

6.5.1.1 See paragraph 6.3.3.

6.5.2 Implementation of at least LNAV approaches for international airports

6.5.2.1 RNP APCH LNAV procedures provides lateral guidance and can be defined with fly-by and fly-over waypoints as "T" or "Y" type approach.

6.5.2.2 RNP APCH is defined as an RNP approach procedure that requires a lateral Total System Error (TSE) of +/-1 NM in the initial, intermediate and Missed Approach Segments (MAS) and a lateral TSE of ±0.3 NM in the Final Approach Segment (FAS).

6.5.2.3 RNP APCH LNAV procedure does not rely on ground radio aids and are more accuracy than conventional VOR/DME procedures. Also improve access being aligned in most cases with the runway centre line.

6.5.3 LNAV/VNAV (BARO VNAV) Approaches if analysis determines a benefit

6.5.3.1 Baro-VNAV approach procedures are classified as APV procedures in support of Type A 3D approach operations. They utilize a DA/H and not an MDA/H, and neither a FAF nor a Missed Approach Point (MAPt) is identified. They use obstacle assessment surfaces similar to those for ILS, but based on the specific lateral guidance system.

6.5.3.2 Baro-VNAV procedures are used in association with LNAV-only procedures. The LNAV-only FAF and MAPt are needed to define the lateral areas and to support the lateral guidance but they are not used for the vertical navigation function.

6.5.3.3 Baro-VNAV procedures shall not be authorized with a remote altimeter setting.

6.5.3.3 Providing lateral and vertical guidance, BARO-VNAV approaches increase safety, access and accuracy compared with an RNP APCH LNAV procedure.

6.5.4 Implementation of RNP AR Approaches if analysis determines a benefit

6.5.4.1 Implementation of RNP AR procedures extends beyond procedure design in that an authorization process for aircraft operators is necessary to ensure that other critical dependencies and associated airworthiness and operational procedure approvals are complete prior to implementation. Guidance on implementation and operational approval is provided in the PBN Manual.

6.5.4.2 RNP AR APCH is defined as an RNP approach procedure that requires a lateral Total System Error (TSE) as low as ±0.1 NM on any segment of the approach procedure. RNP AR APCH procedures are only published where significant operational advantages can be achieved while preserving or improving safety of operation.

6.5.4.3 RNP AR APCH are very useful in mountainous and noise sensitive areas to improve access to the airport through radius to fix RF turns.

6.5.5 Implementation of APV (GBAS) Approaches if analysis determines a benefit

6.5.5.1 Ground-Based Augmentation System (GBAS) is also referred as LAAS (Local Area Augmentation System), it can be used to achieve accuracy required to CAT I-III and is done by locating 4 receivers on the ground at a precisely -surveyed (centimetre accuracy) positions.

6.5.5.2 The cost of one GBAS ground station is less that the cost of multiple ILSs for an airport. Another advantage of GBAS is that the accuracy enhancement is provided for the whole airport.

7. CAR Region PBN Implementation Form

7.1 The CAR Region PBN Implementation Form is included in the **Appendix D** to this Report.

7.2 General

7.2.1 An implementation form has been created in order to help States/International Organizations to determine the level of accomplishment of the airspace model structure.

7.2.2 It is mandatory to indicate an AIP reference as evidence to ICAO NACC Regional Office on each item of the form you agree.

7.2.3 For all longitudinal separation items filled in the form, an existing letter of agreement (LOA) shall be attached.

7.2.4 Information provided by States/International Organizations shall remain confidential in ICAO NACC Regional Office.

7.3 Description of theCAR Region PBN Implementation Form

7.3.1 The CAR Region PBN Implementation Status Form is intended to help States and International Organizations in the assessment of their implementation progress in accordance with the PBN airspace concept. The form has specific initiates for both upper and lower airspace. States/International Organizations shall list all the initiatives they have accomplished or that are in progress to implement and also provide an AIP reference as evidence to ICAO NACC Regional Office on each item of the form agreed. The form has a remark section where States/International Organizations can describe with more detail the status and difficulties they have face or are facing to achieve any of the initiatives listed on the form. At the end of the form a Comments section regarding PBN Implementation roadblocks has been created to provide space to communicate any issue or concern they might have in terms of the Implementation progress.

8. List of Common Challenges to PBN

- Lack of transparency with regards to internal issues preventing PBN implementation.
- Limited Collaborative Decision Making and Communication Channels between States/International Organizations/ANSPs regarding regional PBN implementation.

- Lack of consultation process with stakeholders to obtain feedback about PBN implementation initiatives.
- Lack of trained personnel in terms of PBN concept development and implementation.
- Poor data collection and database management regarding obstacles and aeronautical information.
- Difficulties to obtain proper design tools to develop Terminal and En-route procedures under PBN concept.

9. Templates for RNAV 5 and SID & STAR Development

9.1 Templates for RNAV 5 and SID/STAR help States/International Organizations and ANSPs to design routes and procedures according to a proposed work breakdown with organized tasks, time frames and parties involved. The templates aim to describe and consolidate the procedures/route initiation, data collection and validation, conceptual design, stakeholders, CDM, evaluation, simulation, draft design, safety assessment and others steps that are mandatory in a PBN concept design in accordance with ICAO standards. Both templates are presented in the Appendixes B and C.

10. Reference Documents

10.1 ICAO Reference Documents

a) Performance Based Navigation (PBN) Manual (Doc 9613)

b) Continuous Climb Operations (CCO) Manual (Doc 9993)

c) Continuous Descent Operations (CDO) Manual (Doc 9931)

d) Required navigation Performance Authorization Required (RNP AR) Manual (Doc 9905)

e) Aircraft Operations volume 2- Construction of Visual and Instrument Flight Procedure (Doc 8168)

f) Procedures for Air Navigation Service-Air Traffic Management (Doc 4444)

g) Regional Performance-based Air Navigation Implementation Plan (RPBANIP) for NAM/CAR Regions.

APPENDIX A
Airspaces of the CAR Region

Upper Airspace	Lower Airspace
COCESNA (Central America)	Belize (Belize TMA)
	Guatemala (La Aurora TMA)
	Honduras (La Mesa TMA; Toncontín TMA; Roatán ATZ; La Ceiba CTR)
	El Salvador (El Salvador TMA)
	Nicaragua (Managua TMA)
	Costa Rica (El Coco TMA; Liberia TMA)
Mexico (Mexico & Mazatlán Oceanic)	Acapulco; Cancún-Cozumel; Ciudad Del Carmen; Ciudad Juárez; Ciudad Obregón; Ciudad Victoria; Culiacán; Chihuahua; Durango; Guadalajara; Hermosillo; Ixtapa-Zihuatanejo; La Paz; Los Mochis; León - Aguascalientes; Manzanillo; Matamoros; Mazatlán; Mérida; Mexico; Monterrey; Morelia; Nuevo Laredo; Oaxaca; Puebla; Puerto Vallarta; Querétaro; Reynosa; Saltillo; San Jose Del Cabo; San Luis Potosí; Tampico; Tijuana; Torreón; Tuxtla Gutiérrez; Veracruz; Villahermosa;
Jamaica (Kingston)	Jamaica TMA;
Haiti (Port Au Prince)	Port Au Prince TMA
Cuba (Havana)	Havana TMA; Santa Clara TMA; Santiago TMA
Curacao (Curacao)	Curacao TMA; Juliana TMA; Beatrix CTR; Flamengo CTR;
Dominican Republic (Santo Domingo)	Punta Cana TMA; Las Americas TMA; Cibao TMA
United States (San Juan)	San Juan
Trinidad And Tobago (Piarco)	Trinidad And Tobago (Piarco Ctr)
	Antigua And Barbuda (Vc Bird TMA)
	Barbados (Adams TMA)
	Martinique (Martinique TMA)
	St Lucia (St Lucia CTR)
	St Vincent And The Grenadines (Argyle TMA)
	Grenada (Maurice Bishop TMA)
	Guadeloupe (Pointe-A-Pitre-TMA)

APPENDIX B
ANSP– PBN Route Design Work Flow
Proposed work breakdown plan for development SIDs and STARs for CAR Region in accordance with the CAR PBN Harmonization Sub-Project

TASK #	DESCRIPTION	INVOLVED PARTIES	TIME (APPROX.)	REMARKS
1	Initiation	Stakeholders -Procedure Designers -ASM -ATM - ATS and ANS Safety - Airlines. - Safety Regulations - Any other stakeholder	Variable	Start date based on agreement by ASM and ATM managers & ANS Safety and approval. During this meeting, KEY stakeholders and responsibilities will be identified and a more detailed project plan will be created. Actual time for this phase is dependent on the CDM process and the time it takes for each stakeholder to respond. Based on CDM, a determination will be made on the current number of SIDs and STARs to be designed. This decision does not preclude future requests from any stakeholder.
2	Collection and validation of all data	Procedure designers. ASM, ATS, AIM. CNS Stakeholders. Data sources.	TBD	Start date – Based on agreement by ANS Management. It is **NOT** totally dependent on responses from all stakeholders in task 1. o PBN Equipage data collection ▪ RNAV 1/2 (SIDs and STARs) ▪ RNAV 5 (PBN Feeder routes ▪ RNP APCH (IAPs) o Operational Flight data ▪ Trajectory ▪ Climb and Descent Profiles ▪ ATC considerations ▪ Radar data i. Playback ii. Voice iii. Recording o Terrain and Obstacle o Helicopter Operations
3	Create conceptual design	ASM Procedure designers	TBD	Time is dependent on 1 & 2 being completed.
4	Review by stakeholders	Involved Stakeholders. ASM	Variable	This is dependent on 3 being completed. Time may vary based on responses from stakeholders.
5	Re-design and further CDM if necessary	ASM and required Stakeholders	TBD	To address any critical issues with the initial conceptual design
6	Formal IFP Design and Evaluations	ASM Procedure designers	TBD	Time may be greater depending on design complexities.

TASK #	DESCRIPTION	INVOLVED PARTIES	TIME (APPROX.)	REMARKS
7	Simulation Exercises	ASM Procedure designers ATS & ANS Safety	TBD	Requires simulator exercises to be built. This is for initial validation of the design and is not to be confused with ATCO training. This may require incorporation of ALL designs in order to determine how each procedure affects another. They will provide insight into any possible ATS operational concerns.
8	Create draft IFP chart	ASM Procedure designers	TBD	Dependent on 7 being completed. Time is dependent on design complexities.
9	Document and Store	ASM Procedure designers	TBD	Completion of Procedure and ARINC 424 Coding reports.
10	Conduct safety activities	ASM Procedure designers ATS and ANS Safety	TBD	Recommended to start simultaneously with 7 but also requires 9 to be completed in order for full safety assessment to be conducted.
11	Conduct IFP design verification	ASM Procedure designers	TBD	2 days for first review. 1 day for any corrective actions to be addressed by designer. 1 day for second review. Time may be greater depending on design complexities.
12	Conduct Ground validation	Qualified IFP Validator.	TBD	Time can vary based on availability of resources.
13	Present final design to stakeholders and agreement on effective date	Relevant Stakeholders. ASM Procedure designers ATS & ANS Safety	Variable	Stakeholders' endorsement. Timeline depends on stakeholders' response time.
14	Flight Validation (if required)	Flight Validation service provider. CNS ASM Safety Regulations	TBD	Coordination with CNS regarding the Flight scheduling.
15	ICAO Approval	ASM	TBD	Waypoint 5LNC approvals. ICARD Database update. Time is dependent on ICAO response.
16	IFP Approval	Safety Regulations ASM	TBD	Time dependent on Safety Regulations
17	ATM system update to reflect map/route changes on GRP	ASM Procedure designers CNS ATS & ANS Safety	TBD	Coordination with ATM System provider.

TASK #	DESCRIPTION	INVOLVED PARTIES	TIME (APPROX.)	REMARKS
18	Develop Training Plan and Training Delivery to Operational ATS Staff	ASM Procedure designers ATM ATS & ANS Safety Safety Regulations	TBD	Requires coordination with ATM regarding the development of a training plan and provision of instructors. ATS & ANS Safety to advise of training schedule
19	Submit IFP package to AIM for publication	AIM	TBD	*IFP Data to be submitted 1 month before proposed promulgation date for AIM processing.* *AIRAC supplement to be promulgated 1 or 2 months prior to effective date.*
20	Verify Draft Publication	ASM AIM.	TBD	This will occur simultaneously with 19 and must be completed prior to promulgation of the AIRAC supplement.
21	Implementation	ATS & ANS Safety ASM Procedure designers	TBD	Requires completion of all above tasks
22	Obtain and analyse feedback from stakeholders	ASM	Variable	Post implementation
23	Conduct continuous maintenance	ASM AIM ATS & ANS Safety Airline Operators	Variable	Post implementation
24	Conduct periodic review	Designer. AIM. Safety Regulations	TBD	Post implementation. ICAO requires periodic review to ensure that IFPs continue to comply with changing criteria and meet user requirements, and to ensure that significant changes to the obstacles, aerodrome, aeronautical and navaid data are assessed for their impact on the IFPs. ICAO stipulates review period must not exceed 5 years.

APPENDIX C
ANSP– PBN Route Design Work Flow
Proposed work breakdown plan for continued development of RNAV 5 routes within the CAR Region in accordance with the CAR PBN Harmonization Sub-Project

Task #	Descriptions	Parties Involved	Time (Approx.)	Remarks
1	Initiation	Stakeholders -Procedure Designers -ASM - ATS & ANS Safety - Airline operating agencies - ICAO NACC Offices - IATA - CANSO - Safety Regulations -Adjacent ANSPs - Any other stakeholder	TBD	Start date based on agreement by ASM and ATM managers & ANS Safety and approval. During this meeting, KEY stakeholders and responsibilities will be identified and a more detailed project plan will be created. Actual time for this phase is dependent on the CDM process and the time it takes for each stakeholder to respond. The East/West and North/South traffic flow will be addressed in this project.
2	Collection and validation of all data	ASM, ATS and ANS Safety, AIM, CNS IATA Aircraft Operators Additional Stakeholders.	TBD	Start date – Based on agreement by ANS Management. It is **NOT** totally dependent on responses from all stakeholders in task 1. o PBN Equipage data collect ▪ RNAV 5 o Operational Flight data ▪ ATC considerations ▪ Operator preferred flight routes
3	Create conceptual design	ASM Procedure designers	TBD	Time is dependent on 1 & 2 being completed
4	Review by stakeholders	ASM Procedure designers ATS & ANS Safety Involved Stakeholders.	Variable	This is dependent on 3 being completed. Time period may be varied based on responses from stakeholders.
5	Re-design and further CDM if necessary	ASM Procedure designers Required Stakeholders	TBD	To address any critical issues with the initial conceptual design
6	Formal Route Design and Evaluations	ASM Procedure designers	TBD	Time will depend on design complexities.
7	Simulation Exercises (if required)	ASM Procedure designers ATS & ANS Safety	TBD	This requires simulator exercises to be built. This is for initial validation of the design and is not to be confused with ATCO training. Will provide insight into any possible design flaws.

Task #	Descriptions	Parties Involved	Time (Approx.)	Remarks
8	Create draft aeronautical chart	Procedure designers	TBD	Dependent on 7 being completed. Time will depend on design complexities.
9	Document and Store	ASM Procedure designers	TBD	Process and assimilate all aeronautical data required for safety assessment and publication.
10	Conduct Safety Assessment	ASM Procedure designers ATS & ANS Safety	TBD	**Recommended to start simultaneously with 7** but also requires 9 to be completed in order for full Safety assessment to be conducted.
11	Present final design to stakeholders and agreement on effective date	Relevant Stakeholders. ASM Procedure designers ATS & ANS Safety	Variable	Stakeholders' endorsement. Timeline depends on Stakeholders' response time. It should be noted that this process **MAY** be lengthy as it involves coordination with adjacent ANSPs.
12	ICAO Approval	ASM	TBD	Routes and Waypoint 5LNC approvals. ICARD database updates. Time is dependent on ICAO response.
13	ATM system update to reflect map/route changes on GRP	ASM Procedure designers CNS ATS & ANS Safety	TBD	Coordination with ATM System provider.
14	Develop Training Plan and Training Delivery to Operational ATS Staff	ASM Procedure designers ATM ATS & ANS Safety Safety Regulations	TBD	Requires coordination with ATM regarding the development of a training plan and provision of instructors. ATS & ANS Safety to advise of training schedule
15	Notification to Safety Regulations	State Licensing. ASM	TBD	
16	Submit aeronautical information package to AIM for publication* *(*Logistics for responsibilities still to be finalized)*	ASM AIM	TBD	*Data to be submitted 1 month before proposed promulgation date.* *AIRAC supplement to be promulgated 1 or 2 months prior to effective date.*
17	Verify Draft Publication	ASM Procedure designers AIM.	TBD	This will occur simultaneously with 16 and must be completed prior to promulgation of the AIRAC supplement.
18	Implementation	ATS & ANS Safety ASM Procedure designers	TBD	Requires completion of all above tasks
19	Obtain and analyse feedback from stakeholders	ASM	Variable	Post implementation

Task #	Descriptions	Parties Involved	Time (Approx.)	Remarks
20	Conduct continuous maintenance	Procedure designers State Safety Regulations ATS and ANS Safety AIM	Variable	Post implementation
21	Conduct periodic review	ASM Procedure designers AIM State Safety Regulations	TBD	Post implementation ICAO requires periodic review to ensure that Airspace Organization and Management continue to comply with changing criteria and meets user requirements.

APPENDIX D

PBN IMPLEMENTATION STATUS FORM

Table 1 – STATE/ORGANIZATION INFORMATION

STATE:	Name of State. If not applicable use N/A.
ORGANIZATION:	Name of the Organization.
FIR:	Name of FIR. If not applicable use N/A.
TMA(s):	List the Terminal Area(s) (TMAs) for which the **STATE/ORGANIZATION** has responsibility.
AERODROMES:	List the Aerodromes for which the **STATE/ORGANIZATION** has responsibility.

Table 2 – GENERAL PBN QUESTIONS

QUESTION	ANSWER		REMARKS
Has a PBN Airspace Concept Document been approved by your organization?	Y ☐	N ☐	
Has the PBN Airspace Concept Document been submitted to the ICAO NACC Office?	Y ☐	N ☐	
Is your Aeronautical information Publication (AIP) published online?	Y ☐	N ☐	

Table 3 – UPPER AIRSPACE INFORMATION

UPPER AIRSPACE	**INITIATIVE**	**STATUS** *Statement as to whether task has been achieved.* *Provide evidence in the form of reference to AIP and Scanned page(s)* *If not applicable (for States/Organization who may not have an UPPER Airspace) use N/A*	**REMARKS** *Comments from State/Organization regarding why the task has not been achieved. Projected timeline for completion (if available).*
FIR NAME CONTINENTAL AIRSPACE If not applicable use N/A	Implementation of RNAV 5 routes as agreed to in the Regional ANP		
	Removal of conventional routes made redundant by PBN route implementation		

UPPER AIRSPACE	**INITIATIVE**	**STATUS** *Statement as to whether task has been achieved.* *Provide evidence in the form of reference to AIP and Scanned page(s)* *If not applicable (for States/Organization who may not have an UPPER Airspace) use N/A*	**REMARKS** *Comments from State/Organization regarding why the task has not been achieved. Projected timeline for completion (if available).*
FIR NAME CONTINENTAL AIRSPACE If not applicable use N/A	Implementation of RNAV 1/2 SIDs/STARs (CCOs and CDOs) to TMAs within the FIR		
	Implementation of 20NM longitudinal separation at FIR Boundaries **(WHERE APPLICABLE)**		
	All points corresponding to routes from the regional air navigation plan, published by the State in their AIP, are identical to the coordinates stored in the ICARD database.		

UPPER AIRSPACE	**INITIATIVE**	**STATUS** *Statement as to whether task has been achieved.* *Provide evidence in the form of reference to AIP and Scanned page(s)* *If not applicable (for States/Organization who may not have an UPPER Oceanic Airspace) use N/A*	**REMARKS** *Comments from State/Organization regarding why the task has not been achieved. Projected timeline for completion (if available).*
FIR NAME OCEANIC AIRSPACE If not applicable use N/A	Use of 50 NM Lateral Separation		
	Use of 30NM Longitudinal and Lateral Separation		

Table 4

LOWER AIRSPACE	**INITIATIVE**	**STATUS** *For each Aerodrome and RWY Statement as to whether task has been achieved.* *Provide evidence in the form of reference to AIP and Scanned page(s)* *If not applicable (for States/Organization who may not have Lower Airspace) use N/A*	**REMARKS** *Comments from State/Organization regarding why task has not been achieved. Projected timeline for completion (If available).* *If not applicable use N/A*
Name of TMA If not applicable use N/A List Aerodromes for which the **STATE/ORGANIZATION** has responsibility	Implementation of LNAV approaches for International Airports		
	Implementation of APV BARO VNAV approaches for International Airports **if analysis determines a benefit**		
	Implementation of RNP AR Approaches **if analysis determines a benefit**		

LOWER AIRSPACE	INITIATIVE	STATUS *For each Aerodrome and RWY Statement as to whether task has been achieved.* *Provide evidence in the form of reference to AIP and Scanned page(s)* *If not applicable (for States/Organization who may not have Lower Airspace) use N/A*	REMARKS *Comments from State/Organization regarding why task has not been achieved. Projected timeline for completion (If available).* *If not applicable use N/A*
	Implementation of APV (GBAS) Approaches **if analysis determines a benefit**		
	Implementation of RNAV 1/2 SIDs and STARs		

Table 5 - Comments

COMMENTS FROM STATE/ORGANIZATION REGARDING PBN IMPLEMENTATION ROADBLOCKS

— END —