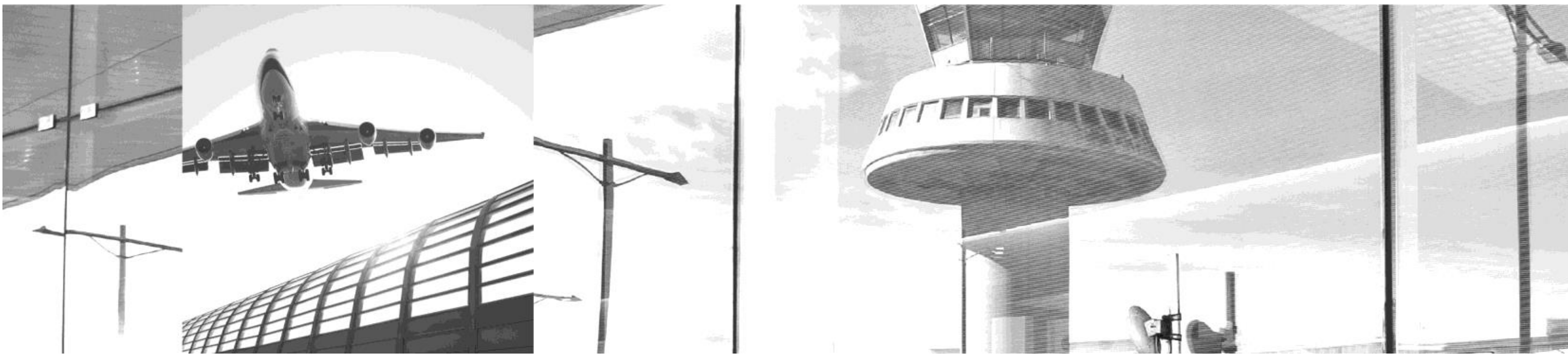

Concept of Operations DC-ANSP airspace and route redesign

Airspace and route redesign TNCF, TNCC (Curaçao) and TNCB (Bonaire)

Commissioned by	Dutch **Caribbean Air Navigation Service Provider (DC-ANSP)**
Date	16 September 2020
Report number	**CONOPS airspace and route redesign TNCF, TNCC (Curaçao) and TNCB (Bonaire)**
Version	2.0

Colophon

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Executed by	MovingDot
Project team MovingDot	Ander Okina, Nienke Jester, Henk Waltman, Justin The, Miranda Ruis, Akos van der Plaat, Stewart Brown, Sigmund Lentze
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Summary

The Dutch Caribbean Air Navigation Service Provider (DC-ANSP) has recognized the need to improve the efficient deployment of ATCOs in its area of responsibility while simultaneously improving the safety and efficiency of its operations.

This Concept of Operations (CONOPS) describes an airspace and route design that meets the user and system requirements. The requirements address a better workload balance, standardized and simplified procedures, and more support for continuous climb and descent operations. The design of the routes and procedures are aimed at improving both Curaçao and Bonaire airports' Standard Instrument Departures (SIDs) and Standard Arrival Routes (STARs).

The CONOPS describes a number of building blocks:

- re-sectorization of the ACC and APP areas, using dynamic airspace use and staffing;
- SIDs and STARs for the most used procedures, that are closer to the actual flight tracks ("Publish what you fly") and deconflicted by design;
- VFR procedures, including reporting points and routes.

The CONOPS provides the requirements and building blocks that are considered and proposed for the design. It states the requirements and guidelines needed for the subsequent global and detailed design process.

1 Introduction

1.1 Background

Over the years the Curaçao airspace has become busier, increasing the workload of the air traffic controllers (ATCos) of the Curaçao Area Control Centre (ACC). At the same time the size of air traffic control staff working the sectors did not follow the traffic developments. A reduction of controller workload and an improvement in controller deployment is urgently needed. Also, both Curaçao and Bonaire airports' Standard Instrument Departures (SIDs) and Standard Arrival Routes (STARs) require maintenance and are sought to be upgraded to support continuous climb operations (CCO) and continuous descent operations (CDO) to further improve flight efficiency.

Therefore, DC-ANSP has started a project to improve the efficient deployment of ATCos in its area of responsibility whilst simultaneously preserving or improving the safety and efficiency of its operations. An airspace and flight procedure redesign will aid in this task. The envisaged project has the following goals:

- Balance the workload of the ATCos in Curaçao's upper and lower airspace (TMA) by means of re-sectorization;
- Simplify the traffic flows by standardization and deconfliction;
- Improve flight efficiency by supporting continuous climb and descent operations.

NOTE: *this CONOPS states the situation reference date January 2020 and pre-COVID. This is particularly true for numbers of traffic and staffing.*

1.2 Goal and scope

The project is divided in two phases, starting with the development of a CONOPS in phase 1 (this report) by which the final design will be made in phase 2. The ultimate objective of the project is to deliver:

- An airspace based on restructuring of the Curaçao Flight Information Region (FIR). This new airspace structure will have less complex operating procedures, will support a more efficient deployment of the ATCos and will be resilient for future growth of air traffic.
- A redesign of the SIDs and STARs to and from TNCC and TNCB airports. The new routes will support CCO and CDO and will allow an optimized separation of inbound and outbound traffic flows. Overall, the operational safety and efficiency of both ATCos and airspace users will be improved.
- A design of VFR procedures to and from TNCC and TNCB. The new VFR procedures will allow a structured way of flying for all VFR aircraft, providing more predictable and optimal routes to and from Curaçao and Bonaire.

Phase 2 consists of delivering these designs to DC-ANSP. This includes an outline of the supporting working procedures and assist DC-ANSP in all activities to have the modified flight procedures, AIP charts and procedure descriptions approved by the Curaçao Civil Aviation Authorities and the Dutch Human Environment and Transport Inspectorate (ILT). The aim is to implement the changes for AIRAC cycle 2105.

The planned dates for major changes for AIRAC 2105 are:

- Cut-off date: 25 February 2021;
- Publication date: 18 March 2021;
- Effective date: 20 May 2021.

1.3 Methodology

Following is a description of the current set-up of the airspace in Curaçao and interviews with operational experts from the different departments of DC-ANSP the existing issues are identified to define specific requirements (in this document referred to as 'REQ'). With these requirements, building blocks that address the issues are proposed. Combinations of these building blocks will form a concept that will be implemented in ATM procedure changes in the second phase of the project. The requirements will also lead to 'design guidelines' (referred to with 'DG'). These specific design guidelines will be complimented by additional generic design guidelines from MovingDot, based on best practices in flight procedure design.

The proposed building blocks and concept included will be reviewed by DC-ANSP and modified when required.

1.4 Assumptions

The Concept of Operations assumes a number of changes to the DC-ANSP ATM system that are not put in operation at the time the document was drafted. These developments are considered and explained. They are listed with the description of the current situation. If future developments deviate from these assumptions, the contents and conclusions in this CONOPS should be re-assessed.

The following list contains the assumptions made in this project:

AS-1	Certification of Space Based ADS-B for terminal en-route airspace. [*Note: this was confirmed for version 1.1*]
AS-2	Introduction of radar data sharing with Santo Domingo.
AS-3	Integration of three surveillance data sources into the ATM system
AS-4	Cross training and/or refresher training of APP and ACC controllers
AS-5	Eventually limiting tower operations to aerodrome control
AS-6	Increase in voice communication lines with adjacent centres
AS-7	Improvement of electronic flight data sharing with adjacent centres
AS-8	Introduction of an Air Traffic Flow Management tool
AS-9	Changes to airspace classes and sizes
AS-10	No changes to protected area dimensions
AS-11	No change to transition altitude and level in the project timeline
AS-12	No improvements to radio coverage in the project timeline

2 Current situation

DC-ANSP is the air navigation service provider for the Curaçao Flight information region, with a staff of about 95. The organization is responsible for providing safe and efficient air navigation services within the Dutch Caribbean airspace, i.e. the Curaçao FIR.

2.1 Airspace organization

Curaçao FIR covers the airspace above the island together with a large section of the Caribbean Sea. It has boundaries with six other FIRs, namely Maiquetía (Venezuela), Barranquilla (Colombia), Kingston (Jamaica), Port au Prince (Haiti), Santo Domingo (Dominican Republic) and San Juan (USA/Puerto Rico). Figure 1 shows the geographical position and general layout of the FIR.

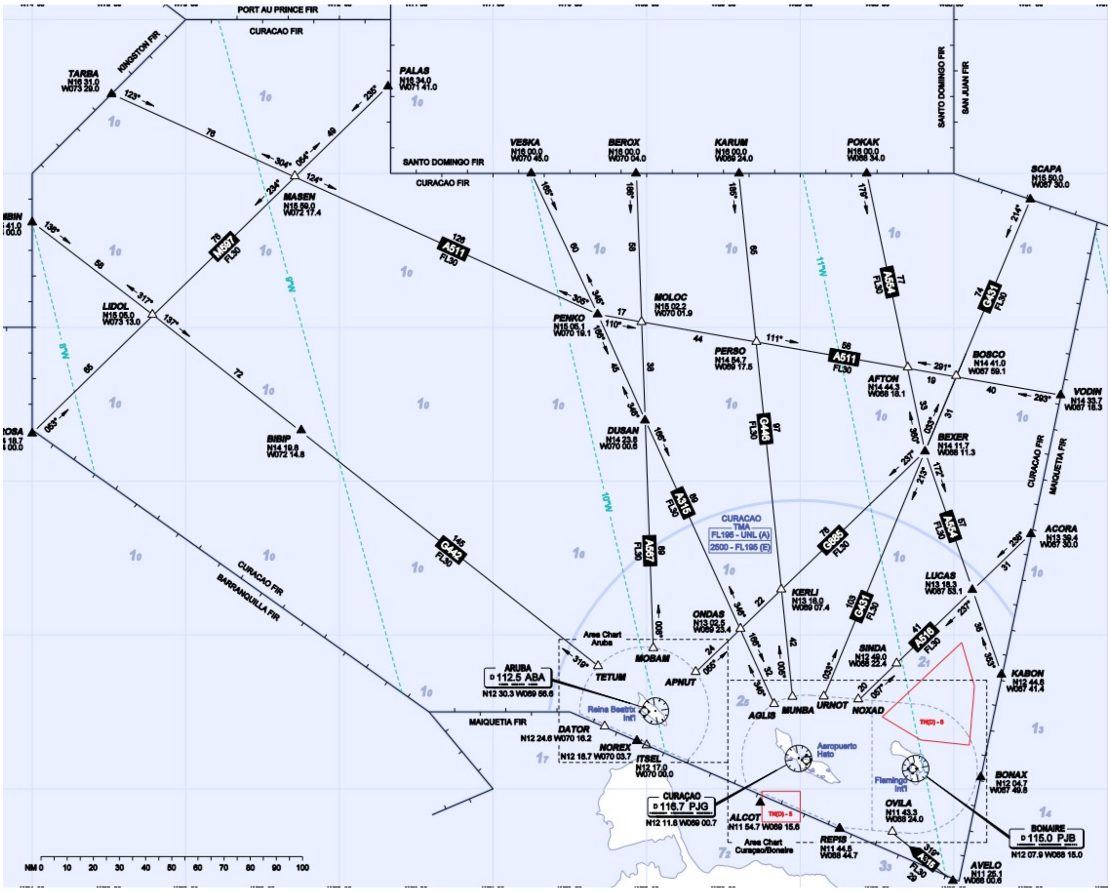

Figure 1 - Curaçao FIR, with the lower airspace structure

Within the FIR, different airspace volumes are defined, which are based on the type of air traffic service being provided (as depicted in Figure 1 and Figure 2):

- one FIR where area control is provided using radar and procedural separation,
- one TMA with a 100 NM radius from Curaçao VOR with radar services,
- three CTR's surrounding the airports of Aruba, Bonaire and Curaçao with surveillance services and procedural control.

- three Aerodrome Traffic Zone (ATZ's) for each airport.

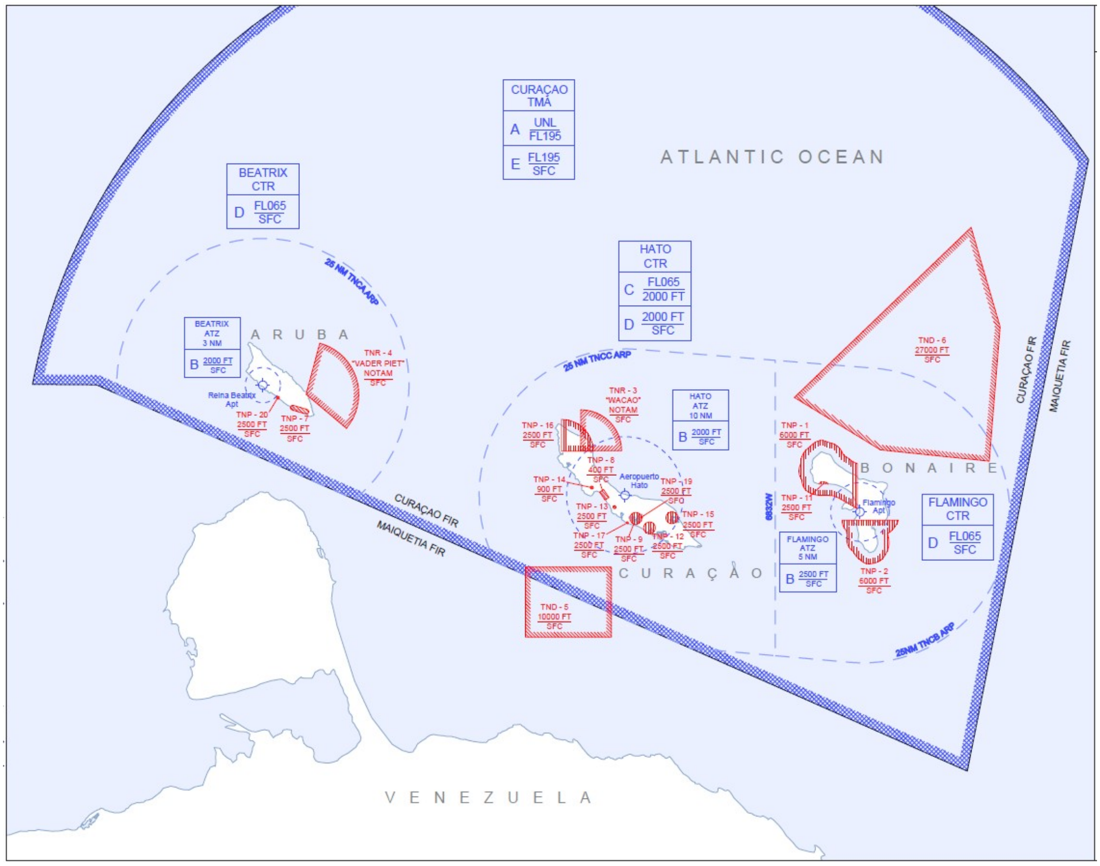

Figure 2 - Airspace structure within the Curaçao TMA, including Beatrix, Hato and Flamingo CTR

2.1.1 Area Control - ACC

Curaçao ACC operates with one D-controller, who communicates with aircraft and issues instructions, and one A-controller, who supports the D-controller primarily by coordinating with adjacent centres. ACC is open 24 hours, but radar services are limited to the busier periods of the day (11:00-03:00 UTC), allowing the Communication, Navigation and Surveillance (CNS) department to perform maintenance activities on the radar system during other times. Area radar control is provided using the Curaçao radar, which does not provide coverage of the entire FIR. In the north-western section of the airspace procedural separation was applied; based on position reports from the pilots time-based separation is applied. In 2019, ACC has taken into operations Space Based ADS-B (see paragraph 2.6.1) certified for en-route and approach control, thus allowing to deliver 'radar services' in the entire area.

The A-controller uses a Flight Data Display System (FDDS) for inputting the FIR entry estimate times and coordinated flight levels, providing the D-controller with up to date information. Once the flight enters the FIR, the D-controller makes inputs into the FDDS when necessary and the A-controller uses this information to provide the next centres with estimate times of arrival. Other ATC units (Hato TWR and Flamingo TWR) also have access to this system for coordination purposes. For communication and coordination with adjacent centres, the D- and A-controllers use 5 non-specific MEVA[1] lines. As such it is not possible to identify who has called without establishing voice communication, thus complicating call backs. Sometimes, due to long communication processes, the D-controller controller answers the phone and supports the A-controller in planning and coordination tasks.

Added to the core ATM system from Raytheon, is a separate Electronic Flight Strip System (EFSS) that provides support to the A-controller. The FDDS sends flight data to the EFSS.
It should be noted that changes made to the EFSS, like changes in flight levels or times, do not automatically feed back into the FDDS, which may lead to incorrect coordination messages to adjacent centres. The only correct way to enter changes, is to make all changes in the FDDS (A-Controller), which will than automatically feed into the EFSS.

Occasionally, Area Control is split between an upper and a lower level, with a division level at FL 245 while keeping the lateral boundaries the same. This split mostly occurs during the weekends and some weekdays during high season.

The horizontal radar separation minimum for ACC, based on the Curaçao long-range radar system or SB ADS-B, is 10 NM. [ref. b]

2.1.2 Approach control - APP

The Hato radar position provides surveillance approach control services and is only active during the busier periods in the afternoon (17:00 – 23:00 local time). To allow on the job procedural approach training in the tower, APP is currently restricted to Friday to Sunday operations.

APP controls traffic departing from and arriving to Hato and Flamingo, but not overflying traffic at lower levels, as these flights are controlled by ACC.

All coordination activities with adjacent centres are done by ACC. Consequently, Hato radar (APP) coordinates through ACC. An exception to this general rule concerns departing traffic to the south, which is coordinated by APP, and coordination with TWR control within the FIR (Hato and Flamingo), Hato radar coordinates directly, without ACC.

After deployment for en-route services, Space Based ADS-B has been deployed for APP as well (see paragraph 2.6.1).

The horizontal radar separation minimum for APP, based on the Curaçao long-range radar system, is 5 NM. [ref. c]

[1] MEVA: "Mejoras al Enlace de Voz del ATS", ATC voice system supplied by Frequentis.

2.1.3 Aerodrome control – TWR

There are the two TWRs: Hato and Flamingo. Both are open according to AIP., however Flamingo TWR is usually not active at night when no traffic is expected and only opens during the night if the need arises.

Only Hato Approach Radar uses radar separation. Hato TWR may provide procedural approach control.

The area of responsibility of Hato TWR includes Hato CTR, Hato ATZ and the maneuvering area of Hato Airport. When Hato Radar is active, the area of responsibility of Hato TWR is reduced to the maneuvering area and the aerodrome traffic circuit of Hato Airport.

The area of responsibility of Flamingo TWR includes Flamingo ATZ and the maneuvering area of Flamingo Airport. When Hato Radar is active, the Flamingo CTR - excluding the Flamingo ATZ - is the area of responsibility of Hato Radar. When Hato Radar is not active, the Flamingo CTR – excluding the Flamingo ATZ, is the responsibility of Curaçao ACC.

2.1.4 Prohibited, Restricted and Danger areas - PRD

Within the Curaçao FIR there are a number of PRD areas that affect the operation of flights and the design of procedures, seen in red in Figure 2. Bonaire island is surrounded by prohibited areas TNP-1 and TNP-2 both north and south of the airport up to 6000 ft, reducing the space for IFR procedure design and VFR operations, e.g. the available room for the traffic circuit.

The military area TND-6, which is activated by NOTAM, is north-east of Bonaire airport up until FL250. This area has been reported as not active for the last decades (since approx. 1980) and is expected to remain unchanged. The TND-6 area will not be considered as a limiting factor for the IFR procedure design.

2.2 Departure and arrival procedures for Curaçao and Bonaire

Current departure and arrival procedures for Curaçao and Bonaire were not designed for continuous climb and descent (CCO/CDO) operations and not deconflicted by design. In the current operation, flights are usually given a direct to the Initial Approach Fix (IAF) from the FIR entry point, taking them off the ATS route, thus deviating from the standard procedure published in the AIP. This suggests that airlines plan for a longer route than is actually flown, resulting in a fuel efficiency loss. Moreover, the method of clearing aircraft direct to the IAF creates challenges for the ATCos as traffic may not be separated or sequenced, which is consequently solved during the last part of the flight, when closer to the airport.

2.3 Traffic flows in Curaçao airspace

2.3.1 En-route traffic flows

The majority of traffic in the Curaçao FIR (about 80%) comprises of en-route traffic, transiting above FL245. The busiest days are Fridays, Saturdays and Sundays. The busiest en-route traffic flow patterns are shown in the figure below. (Based on EFSS information for all of 2018.)

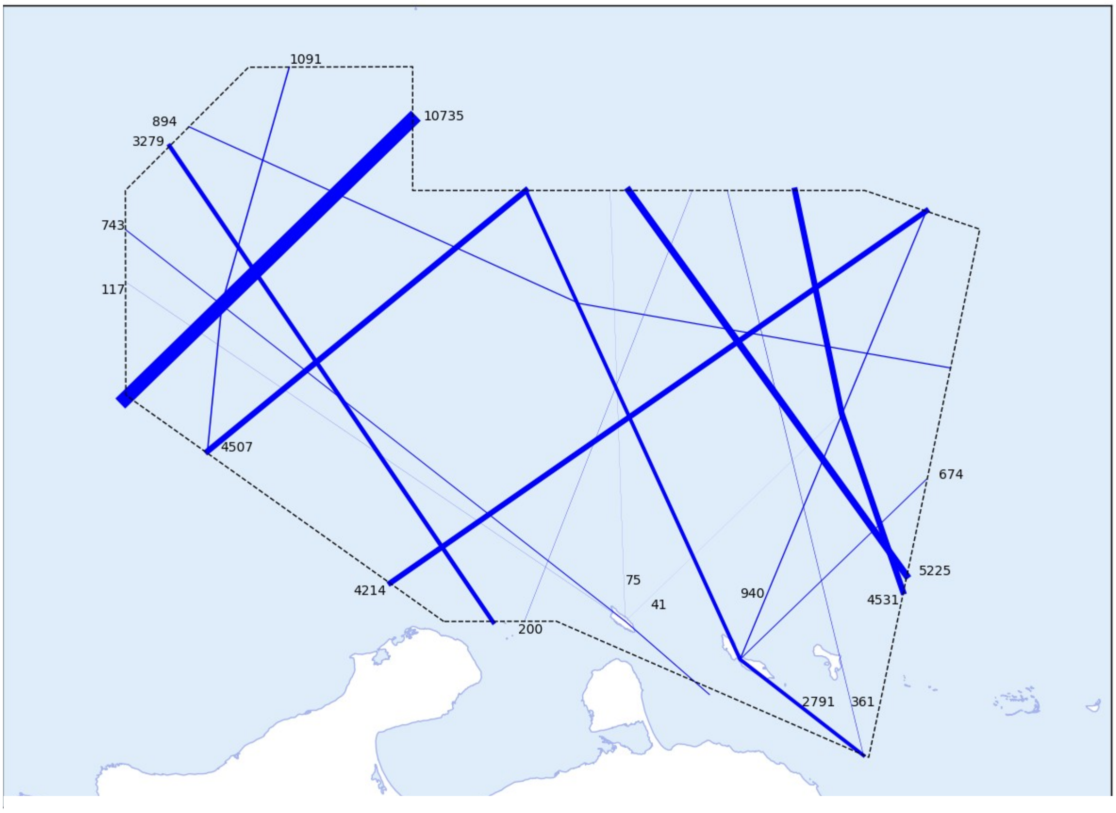

Figure 3 – En-route traffic flows in Curaçao FIR (2018 data)

2.3.2 Arriving and departing traffic flows

The second biggest part of the traffic in the FIR are flights arriving at and departing from the three islands: Aruba, Bonaire, and Curaçao. Most of the international traffic to the airports of Curaçao and Aruba arrives from the north of the FIR, with some traffic from Europe arriving from the north-east. The numerous inter-island flights are often VFR traffic.

2.3.3 Evolving en-route traffic crossing southern FIR boundary

From the en-route traffic, there is a group of flights arriving and departing from northern Venezuela. Due to the close proximity of the northern Venezuelan airports from the Curaçao FIR, these flights need to be considered separately from the rest of the cruising traffic, as they fly climbing or descending at lower flight levels and could therefore (briefly) cross the new Curaçao Approach Area.

It is an undesirable side-effect of the Approach Area ceiling if these flights would be under APP control for a very short time.

Considering the ‘worst case’ for this situation, a descending flight leaving the FIR at AVELO. AVELO formally is only an entry point, but it is the closest point to Maiquetía airport.

For procedure design, according to PANS-OPS (ref. a), 5% is the usual value used for an average descent. Considering leaving the FIR at AVELO, at a distance of 80 NM from Maiquetía airport, this gives an altitude of approximately 25,000 ft at the exit point if the aircraft were to descent along a direct route between both points. In this case, the altitude at AVELO would be **above FL245**.

In actual operations, flights transfer to Maiquetía FIR through ALCOT, not through AVELO, which is 120NM away from Maiquetía airport. This means descending traffic will cross the FIR boundary even higher, and higher above FL245.

As an illustration, below some examples as extracted from ADS-B data. It shows flights pass the FIR boundary at altitudes higher than FL245.

Figure 4 contains the example of Turkish Airlines flight TK183, arriving from Havana (Cuba), on the 19, 21 and 23 of November of 2019. The flights left the Curaçao FIR through ALCOT at cruise altitude (FL410 or FL390 in the analyzed days) to start descent right after entering Maiquetía FIR.

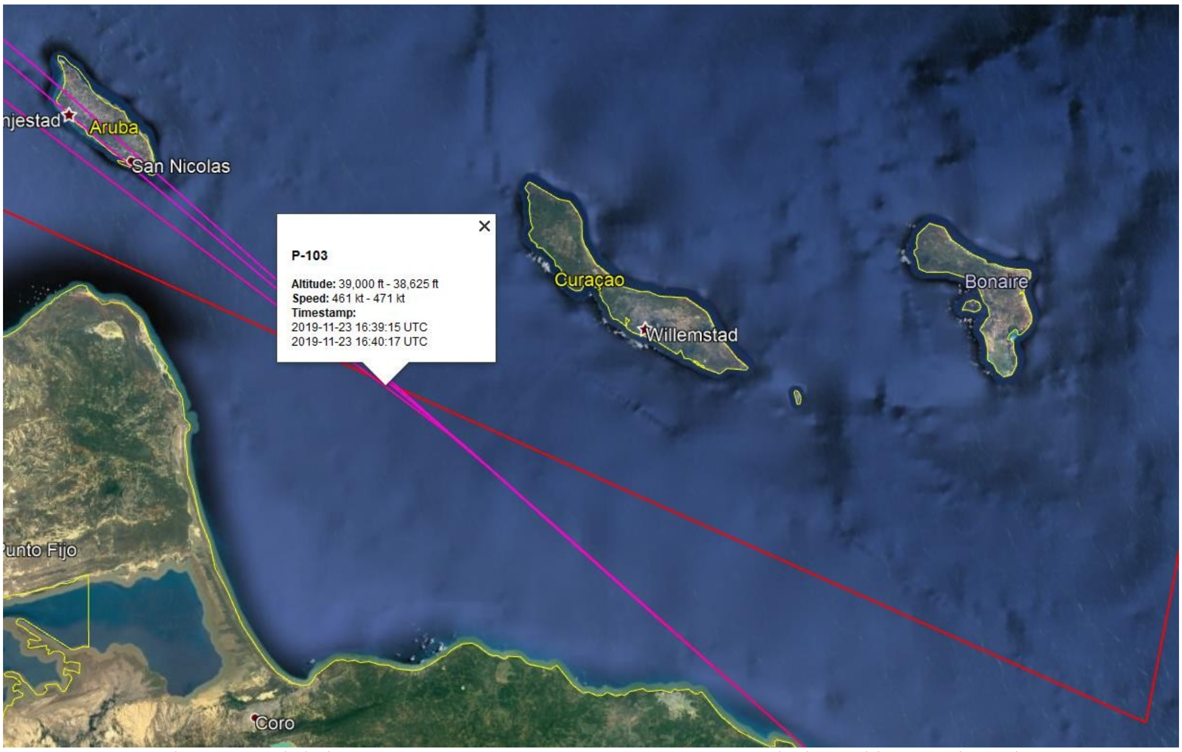

Figure 4 - Example of arrival flights into Maiquetía airport passing ALCOT, with the red line marking the Curaçao FIR boundary, and pink lines showing the flight tracks.

In the case of climbing flights, a typical flight to Havana was considered, using three different flights from 13, 14 and 17 November 2019. These flights entered Curaçao FIR through waypoint AVELO, at an altitude **between FL250 and FL270** when crossing AVELO. These flights, flown with an Embraer E190, showing a good average performance for flights operating out of Venezuela.

Overall, it can be considered that Venezuelan evolving flights, both ascending and descending, will typically be above FL245 if crossing the Curaçao FIR boundary on the closest point to Maiquetía airport.

2.3.4 Traffic load distribution over 24 hrs

Most of this arriving and departing traffic is active in the afternoon period, as indicated in Figure 5, where the yearly average traffic demand in 2018 is shown. Traffic in Bonaire is less than the other two airports, with mostly inter-island flights or flights arriving on weekends. The overflying traffic follows a similar time pattern as in the airports, with very few flights at night-time, mostly in the early morning hours.

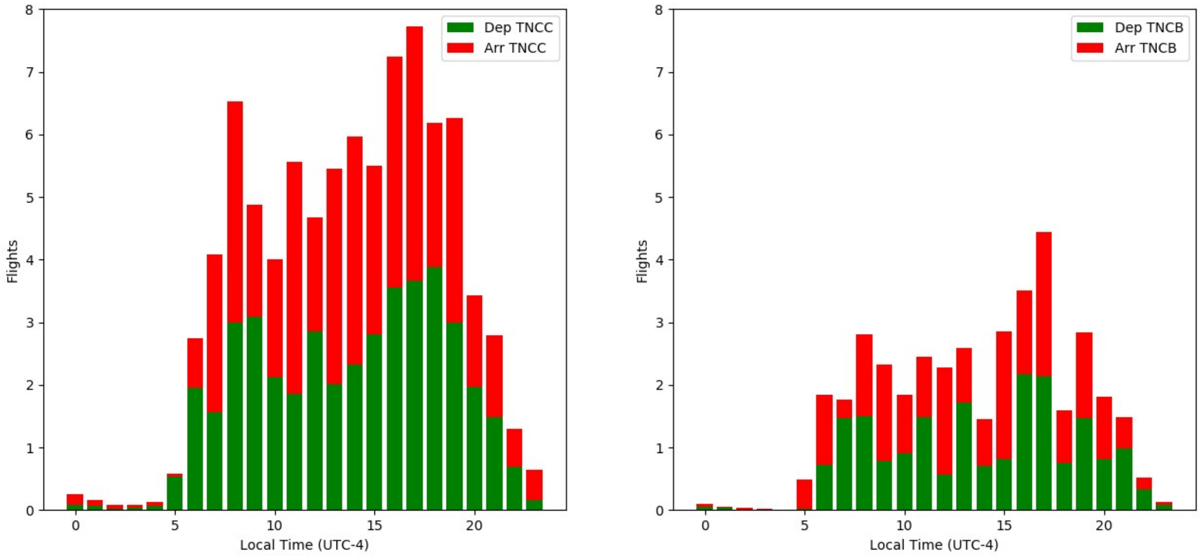

Figure 5 - Operations per hour at Curaçao and Bonaire airports (averages 2018)

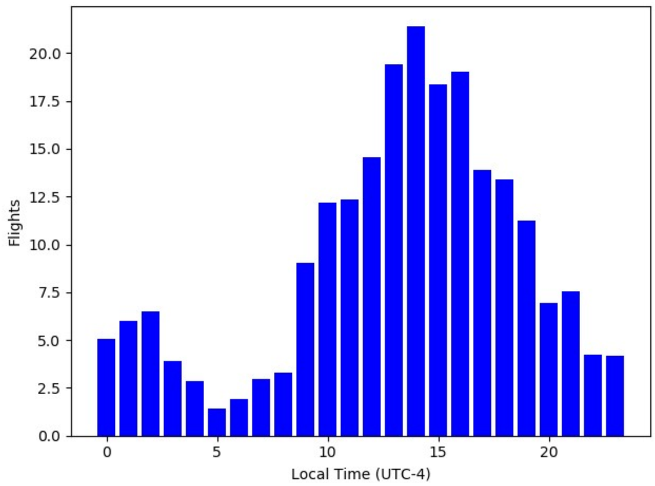

Figure 6 - En-route traffic demand in the Curaçao FIR (TNCF) (averages 2018)

2.3.5 Dominant runway use

With the predominant eastern winds in the region, both runway 11 (RWY11) at Curaçao and runway 10 (RWY10) at Bonaire are the most commonly used runways. Moreover, the runway configuration on Aruba, Bonaire and Curaçao is most of the time the same (east or westerly configuration).

2.3.6 VFR traffic flows

VFR traffic mostly consists of traffic between the three islands in the FIR and to/from Venezuela. This traffic can be roughly divided into two types of traffic: scheduled inter-island flights, and ad-hoc flights to and from the south.

Most of the VFR flights between the islands are scheduled traffic by inter-island airlines. Under dominant runway configuration use (RWY10/11), VFR flights departing from Hato airport to Flamingo fly a straight heading towards Flamingo airport at 3,500 ft as both runways are virtually aligned. For the flight back, the same concept applies but at an altitude of 4,500 ft). The inter-airport scheduled flights used to be single pilot operations, but recently local carriers started two pilot operations, meaning they are certified to fly IFR inter-island flights as well.

The ad-hoc VFR operations take place mostly between the islands and neighbouring countries like Venezuela and Colombia. Experience has shown that Venezuelan VFR traffic is frequently unprepared and unaware of existing procedures in the Curaçao FIR and airports within it.

While there are flight schools in both Curaçao and Bonaire, the number of training flights are very limited.

2.4 Recently redesigned Aruba departure and arrival procedures

The SIDs and STARs for the Aruba airspace (TNCA) were recently redesigned for the Aruba Air Traffic Service provider ANSA. Figure 7 provides an overview of the Aruba procedures.

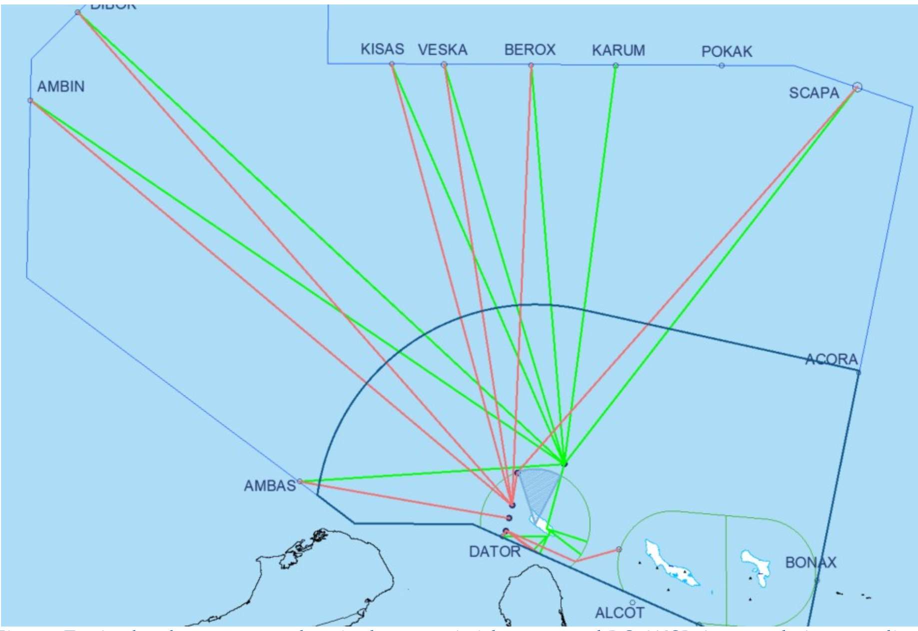

Figure 7 - Aruba departure and arrival routes (with proposed DC-ANSP Approach Area outline)

2.5 Number of operational staff

As per January 2020, 24 + 4 trainee ATCos provided area control services in the Curaçao FIR. Another 25 ATCos provide tower and approach control in Hato and Flamingo airports; 18 at Hato and 7 at Flamingo. Figure 8 shows more details on staff counts at DC-ANSP.

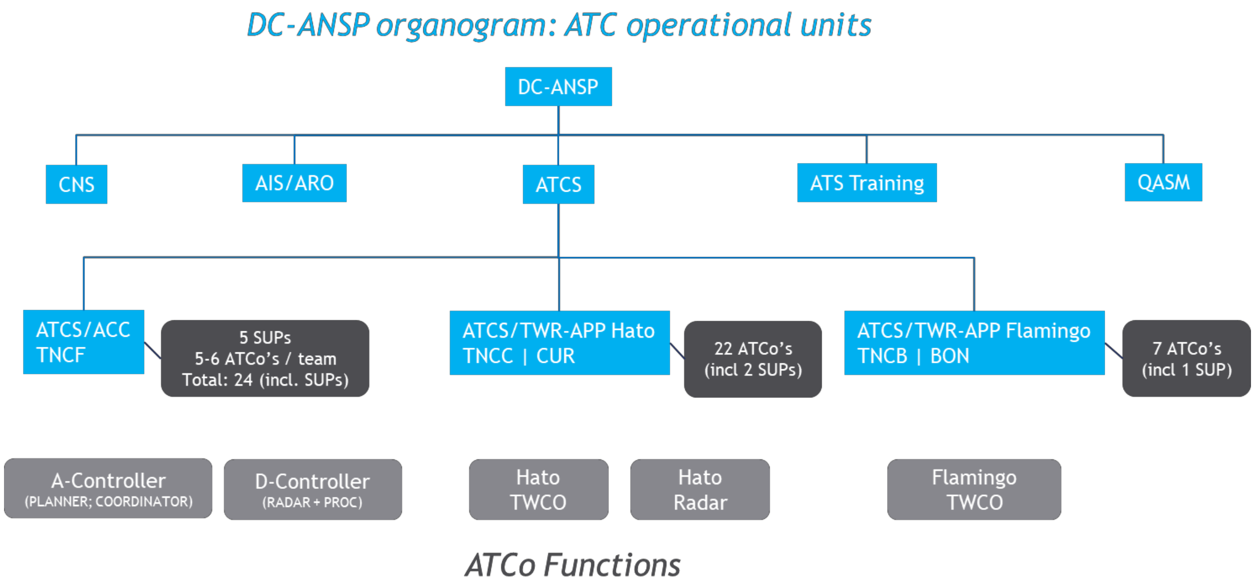

Figure 8 - DC-ANSP operational staff organization diagram

2.6 Future development

There are several items under development or consideration by the DC-ANSP management, which may affect the future use of the ATM system and airspace design. These are briefly discussed below.

2.6.1 Future developments with impact on the airspace redesign

The developments listed in this paragraph are assumed to change the DC-ANSP ATM system and will have an impact on the redesign.

Space Based ADS-B (SB ADS-B)

Space-Based ADS-B services are implemented, which provide full surveillance coverage of the entire Curaçao FIR. This service became operational in late 2019. With the integration of the SB ADS-B data into the radar system, SB ADS-B will be used for radar services in the entire DC-ANSP airspace.

Starting January 1, 2020, a mandate (ref. h) for ADS-B equipage is in effect for all operators flying in the north-west corner of the Curaçao FIR in the RVSM airspace (above FL290). By 2021, the mandate will extend to the entire RVSM airspace, and it will not be until 2023 when the mandate will apply to the entire airspace. This means DC-ANSP will still have to cater for flights without ADS-B until 2023, which can be accommodated in the airspace below FL290.

In 2019, DC-ANPS confirmed that the SB ADS-B was certified for en-route radar service, with a horizontal surveillance separation minimum of 10NM for usage in the approach and en-route airspace. Aireon is seeking system certification for approach control use in the Approach Area, which would allow DC-ANSP to apply lower separation minima.

The certification of the Space Based ADS-B for terminal en-route and approach environments was assumption **AS-1** of this project 'Phase 1'. At this time (after release of version 1.0 of the CONOPS), DC-ANSP confirmed certification for both en-route and approach services.

Santo Domingo radar surveillance feed

Radar data sharing will be introduced with Dominican Republic to provide improved radar coverage in the northern region of the airspace. These new services will allow for the provision of radar services in the entire Curaçao FIR during the whole day. This would result in both an extension in radar services provision and area of coverage.

The deployment into operations of the system by the time the new airspace structure is introduced is the assumption **AS-2** of this project.

Integration of three surveillance data feeds

The integration of three surveillance information sources (Curaçao radar, SB ADS-B and the Santa Domingo radar) into the DC-ANSP ATC system aims at providing full surveillance coverage within the entire Curaçao FIR.

The surveillance data feeds are already integrated into the ATM system and being tested for becoming operational in the short term. The three data feeds being operational and integrated into the ATM system is assumption **AS-3** of this project.

Increasing number of ACC controllers and cross-training APP-ACC controllers

In the near future, DC-ANSP intends to increase the number of ACC ATCos. Currently there are 24 ACC ATCOs and the intent is to expand this team by 5. Furthermore, cross-training of ACC and APP controllers will increase the number of available personnel for en-route and approach radar control service in the Curaçao FIR.

The cross training and/or refresher training of APP-ACC ATCos being finished in time for the full introduction of the new airspace and dynamic airspace use and staffing is assumption **AS-4**.

Limiting tower operations to aerodrome only

In line with the expansion of radar service for approach and the cross-training of ACC and APP controllers, DC-ANSP has decided to limit tower operations to aerodrome control only for both Curaçao and Bonaire.

Limiting tower operations to aerodrome only by the time of the introduction of the new airspace is assumption **AS-5** of this project.

Increasing the number of telephone lines with adjacent centres

New communication lines with adjacent centres are being implemented in the Curaçao operations room with the objective of improving communication and coordination activities. MEVA (*Mejoras al Enlace de Voz del ATS* in Spanish) lines, regional voice communication lines, are already in place and expected to be implement further. These lines are specific, meaning the controller will be able to identify who is calling, as opposed to older MEVA lines. ADD: more lines, caller id later. Dedicated line per adjacent centre to identify.

The lines are already installed and most of them working, except for the MEVA line with Barranquilla. All communication lines being operational by the time the redesign is implemented is assumption **AS-6.**

Improving the electronic flight data exchange with adjacent centres

The renewal of the DC-ANSP ATM system in the coming years, will improve the electronic flight data exchange with adjacent centres. This item is assumption **AS-7**.

The improvement is in line with the ICAO initiatives for the Latin America and Caribbean region that includes an improvement of the electronic flight data exchange with other centres by the year 2020.

Air Traffic Flow Management System (ATFMS)

To better manage traffic loads, DC-ANSP has initiated improvements to the Air Traffic Flow Management System (ATFMS). These improvements should smoothen traffic load spikes, e.g. when 3 Divi flights and 1 intercontinental flight are scheduled to arrive in a small time-window.

The introduction of ATFMS is also considered to reduce the workload as it would allow for staff rostering and dynamic staffing based on the expected traffic load.

The introduction of a basic form of an ATFMS in time for the redesign of the airspace is assumption **AS-8**.

Harmonizing airspace classification

DC-ANSP stated that the airspace redesign should take into account the envisaged harmonization of airspace classes (assumption **AS-9**). Harmonizing the airspace classes aims to achieve a more standardized airspace. Figure 9 summarizes the proposed airspace changes. The implementation of this change has not been formally approved by the authorities yet.

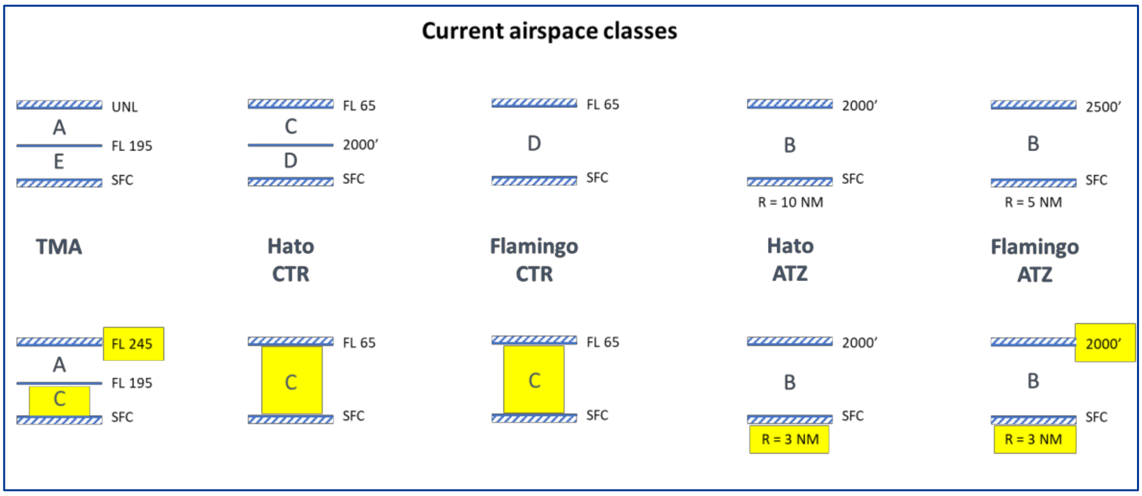

Figure 9 - Proposed airspace classes after implementing changes (in yellow)

For reference, the Aruba CTR stretches from SFC to FL 65, with airspace classification D. The Aruba ATZ is classification B, extents from SFC to 2,000 ft and has a 3 NM radius. Raising the Aruba CTR airspace class to C is presently part of discussions between DC-ANSP and ANSA.

2.6.2 Future developments that are uncertain or with limited impact on the airspace redesign

Several developments are deemed to have a limited impact on the current airspace and route redesign project or are not considered because they are too uncertain. These are listed below.

Resizing prohibited areas TNP-1 and TNP-2

Both TNP-1 and TNP-2 are prohibited areas intended to protect the flamingos on the island of Bonaire. These two areas reach up to 6000 ft and cover most of Bonaire island, as seen in Figure 9. Resizing of these two areas is being considered by BES authorities (on consideration by DC-ANSP) to not only allow more freedom for a more efficient design of the SID and STARs, but also provide more area for the VFR traffic circuits.

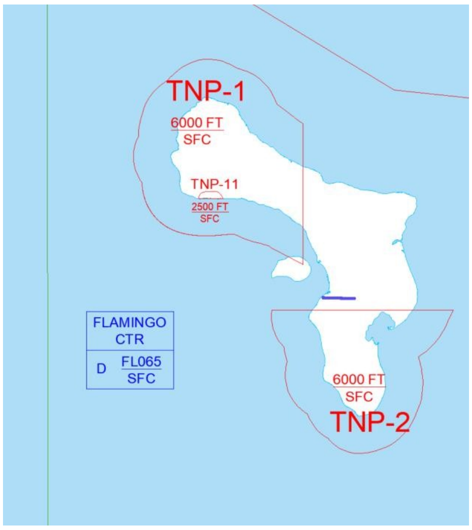

Figure 10 - TNP-1 and TNP-2 situation around Bonaire airport

TNP-2 severely limits operations to the south side of the runway.

The future shape or ceiling altitude is currently unknown. Resizing is an on-going topic for DC-ANSP, but the outcome is uncertain at this point in time. Unless any updates occur during the early design phase of the project, the project will assume the current area dimensions for the design (**AS-10**).

Change of the transition altitude and transition level

The transition altitude for the airports in the Curaçao FIR is currently 2,500 ft. DC-ANSP states that this is 500 ft under the recommended ICAO value (ref. a, para 2.1.2.4) and is considering a change of the transition altitude to at least 3,000 ft.

According to DC-ANSP pilots are of the opinion that the current transition altitude is too low as the SID and STAR procedures would require continuous monitoring and action at low levels.
In addition to considering a minor change of the transition altitude, it is worthwhile noticing that inter-island flights operate at low altitudes (2,000 ft / FL 45), very close to the transition layer.

Additionally, DC-ANSP states that harmonizing with adjacent centres is difficult. For example, the airports closest to the Curaçao FIR have different transition altitudes: SVJC 5,000 ft, SVMI 12,000 ft, and SVVA 10,000 ft.

Currently, a change of the transition altitude is not considered in the airspace redesign (**AS-11**). This airspace design project will not impede a change of the transition altitude and level in the near future.

Improved radio coverage

Current radio coverage does not reliably cover the entire Curaçao FIR. DC-ANSP intends to improve this situation by making improvements to its ATC radio system. Furthermore, DC-ANSP considers Controller-Pilot Data Link Communications (CPDLC) as a possible mean to resolve this shortcoming in the long term. CPDLC will not be addressed in the current airspace and route redesign effort.

These activities are still in an early discussion process and will not be taken into account in the airspace redesign (**AS-12**).

3 Requirements for new design

DC-ANSP put forward three high level requirements for the airspace and route redesign:

Req. 1. Balance the workload of the ATCOs in Curaçao’s, by means of re-sectorization;

Req. 2. Simplify the traffic flows by deconfliction and standardization;

Req. 3. Improve flight efficiency by supporting continuous climb and descent operations.

Req. 4. Standardize VFR procedures and separate VFR and IFR flows by design

Underlying the three high level requirements are specific issues DC-ANPS observed, that need to be addressed in this CONOPS. Those issues are:

- *High workload for the D-ATCo, the A-ATCo and the Hato Radar-ATCo.*
  The workload depends greatly on the traffic load, both the number of flights and their specifics, as well as the ATCo positions manned.
- *ATCo depending operational practice, deviating from standard operations.*
  To provide better service, ATCos often do not follow the standard procedures. Although this leads to shorter routes and flying times, it also leads to working methods that vary depending on the individual controller.
- *High workload from inter-island traffic.*
  Especially the traffic between the three islands is very different from the international departure and arrival. Inter-island traffic operates on both IFR and VFR procedures (although commercial operators are always able to fly IFR), and flight paths are at times in the way of traffic on the SIDs and STARs, as the runways are almost in line. Following the extended centreline will bring a flight close to the runway on the next island.
- *Published procedures are inefficient.*
  The current procedures are judged inefficient by ATCos, leading to deviation using executive control. From the airline perspective, flight need to plan for the published routes, which may lead to carrying more fuel than required.
- *VFR procedures are absent.*
  VFR traffic is to a certain extent unpredictable and adding substantially to the workload, partly because of the absence of adequate VFR procedures. Published VFR procedures would improve predictability of the VFR traffic and support controlling VFR traffic more easily and separate it from IFR flights more orderly.

Summarized, the issues reflect a workload balance and simplification and standardization of flight procedures as the most prominent areas of improvement.

3.1 Factors that lead to a high workload

To better understand the workload imbalance, this paragraph provides a list of contributing factors. As the two ATCos have very different reasons for an increased workload, they are listed separately.

The major factors raising the workload for the D-controller (the ‘executive controller’) are:

- *A split focus on the radar display and on traffic intent.*
  Controlling both en-route and approaching/departing traffic at the same time leads to two different focuses of attention. This happens because of the difference in the location on the screen (en-route mostly top left, approach mostly bottom right), as well as because of the different types of traffic and anticipating their intent is different (en-route versus approach traffic).
- *Separate ranges for speeds and distances.*
  The behavior of the two types of traffic are different in range, with higher speeds and larger turn radii for en-route traffic compared to the slower approach traffic flying turns more tightly.
- *Dual control principles: procedural and radar services.*
  The lack of radar coverage in the north west corner of the FIR requires procedural control. However, radar services are provided by the same controller in the rest of the area of responsibility. The recent introduction of the Space Based ADS-B counters this dual control principle.
- *Non-standardized practice: controller dependent, always tailored for a specific flight.*
  The daily practice to deviate from standard procedures leads to extra workload. Subsequently, when high traffic load occurs, ATCos return to the standard procedure. The reverse practice is preferable: applying standard procedures by default and deviating from procedures to solve exceptional situations.
- *Occasional overflow for A-controller planning and coordination*
  When the A-controller is not able to respond to coordination calls due to other work, the D-controller occasionally picks up the phone instead.

For the A-controller (the ‘planner-coordinator’ or ‘Flight Data Position’) the major factors raising the workload are:

- *Significant coordination with adjacent centres (per flight).*
  On a regular basis, the coordination with adjacent centres takes significant time, sometimes even several minutes per flight.
- *Much manual work to enter and/or complete flight plan data (missing data).*
  Lacking system coordination also requires entering flight id and intent (flight plan data) manually. At times flight plans are completely missing from the system.
- *No ID on incoming calls, no option for call-back.*
  The current MEVA lines do not provide caller id, which impairs any option to promptly return a call as soon as other A-controller activities allow.

3.2 Envisioned workload issues after system updates

The foreseen system updates bringing full radar service to the entire FIR and improved system coordination facilities and MEVA lines, aim to significantly lower the described workload.

For the D-controller the dual control and occasional overflow should no longer add to the problem as it does today. For the A-controller all issues mentioned above should be reduced to a very large extend by the system improvements.

Verification of the envisioned workload reductions is part of the safety assessment of the airspace redesign.

3.3 ICAO design requirements

ICAO puts out a number of design requirements that are relevant for the airspace and route redesign that MovingDot will meet in the redesign results.

Req. 5. ICAO compliant procedures and naming

3.3.1 ICAO compliant procedures

All procedures shall be ICAO PANS-OPS compliant, depending on the applicable ICAO Procedures for Air Navigation Services – Aircraft Operations. Doc 8168 Vol I and II.

3.3.2 ICAO compliant naming

MovingDot will propose naming of SIDs and STARs that is ICAO compliant. Whenever applicable, they will also comply with ICAO Circular 353 “Transition Planning for Change to Instrument Flight Procedure Approach Chart Identification from RNAV to RNP”.

4 Building blocks for a new operational concept

4.1 Building blocks and design guidelines

The following sections describe the individual building blocks that when combined will satisfy the requirements. They describe an operational concept for implementation in the Curaçao airspace. Building blocks are not necessary for all parts of the new operational concept. DC-ANSP will decide which building blocks are combined to reach the required end result. While not all building blocks directly affect route and airspace design, all are part of the proposed operational concept as presented in Chapter 5.

With the building blocks, this document also provides guidelines that indicate how a building block should be designed to meet the required goal. These design guidelines (indicated with 'DG') are intended to provide more detail and to make the work during the Flight Procedure Design as straightforward as possible.

4.1.1 Building blocks

Nine building blocks are proposed in addressing the requirements presented in the previous chapter:

1. Airspace design
    a. Airspace re-sectorization
    b. Dynamic airspace use and ATCo staffing
2. SID/STAR design
    a. "Fly as published, publish what you fly" procedures based on actual tracks
    b. Publish procedures for "Most of the time"
    c. Deconflicted by design
    d. 'Direct' routes (or optional gates)
    e. Optional arrival holding
3. VFR procedure design
    a. Routes, reporting points and optional circuit area
    b. Optional Approach protection area

Each building block is explained individually in the sections following and corresponding design guidelines are provided wherever relevant.

4.1.2 General design guidelines

The first two general design guidelines were established and agreed as a first step to deliver a standardized, comprehensible, and efficient set of new procedure designs.

DG-1 Maintain the same design approach for the procedures of all three islands,
with deconflicted departure and arrivals reaching the FIR border.
DG-2 Base design on most used runways: RWY11 for TNCC and RWY10 for TNCB.

4.2 Building block 1a: Airspace re-sectorization

The redesign of the Curaçao TMA into an airspace for the purpose of approach control aims to improve the workload imbalance. The imbalance in workload could be addressed by:

- creating an area of responsibility for ACC, which includes the entire upper region of the FIR and the lower airspace of the northern part of the FIR, and
- creating an area of responsibility for lower ACC / Approach control, which includes the lower airspace of the southern part of the FIR.

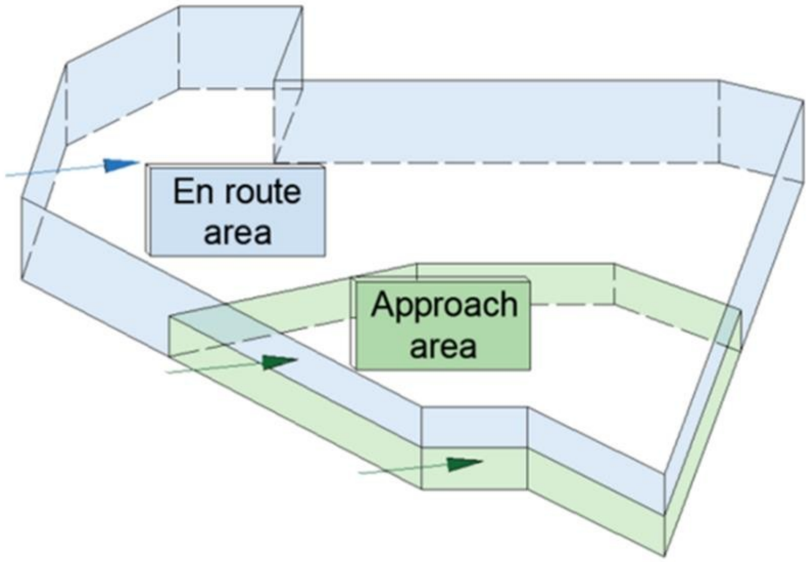

Figure 11 – Proposed conceptual airspace sectorization, with an En-route and an Approach Area. The Approach area will be renamed "Lower ACC"

The horizontal and vertical bounds of both areas of responsibility will have to be defined based on various criteria, taking into account:

- the distance to the three airports from the boundary, to give the APP controller enough airspace to sequence traffic,
- the descent and climb profiles of the aircraft flying in and out of TNCA, TNCB and TNCC,
- the crossing of inbound and outbound traffic, keeping the potential conflict far enough from any traffic hand-over point to prevent misunderstandings on controller responsibility,
- evolving traffic to and from Venezuela, that could possibly fly through the new Approach Area

As the current TMA design does not meet the requirements and criteria put forward in this document, a new Approach Area will have to be defined. One of the aspects that will change compared to the current structure of the TMA, is the TMA airspace west of the island of Aruba. The distance from the TMA boundary to Beatrix CTR is too short to allow vectoring traffic within that space; the ATCo only has the flight under control for a very short time. Extending the Approach Area towards the west will allow more space for the ATCos to take action in case delaying or vectoring is required and will result in a similar handling of flights to all three islands.

NOTE: for operational implementation, DC-ANPS renamed this Approach Area to *"Lower ACC Area"*.

Evolving traffic from and to Venezuela should be considered for design of the new airspace, as it could cross the Approach Area only briefly. In section 2.3 it was concluded that flights are expected to remain higher than FL245, which will allow to specify the boundaries of the airspace without complicating 'balconies' while this traffic will be under the control of ACC only.

The following specific design guidelines apply:

DG-3 ***Traffic type related airspace***
The areas are designed around the type of traffic controlled in every area: Area Control is mainly responsible for level transiting traffic (including evolving traffic from Venezuela). Approach Control handles descending and climbing traffic, and provides sequencing for the approaches to the three islands. Aerodrome control remains in the Aerodrome control zone (the Curaçao and Bonaire ATZs and circuit area's).

DG-4 ***Sufficient time and airspace to handle traffic***
Especially controlling traffic west of Aruba and south of the islands, limited airspace may lead to very short times flights are within the Area of Responsibility (AoR) of Approach. Leaving enough space from the Approach Area border to the CTR border will solve this issue.

DG-5 ***Keep airspace borders away from potential conflict areas, for clearly defined responsibility of potential conflicts***
The location of crossing traffic will always be within the AoR of a single ATCo, to ensure that the conflict falls within the area of responsibility of one controller, without any ambiguity.

4.3 Building Block 1b: Dynamic airspace use and ATCo staffing

As already mentioned in the current situation description in chapter 2, there is an initiative for the DC-ANSP approach (APP) controllers to be licensed for area control (ACC), and training of controllers for tower only. This would enable to have a group of ACC ATCos that can provide services in both areas. (*Note Section 5: CONOPS: En-route Area and Approach Area. DC-ANSP naming: "Upper ACC" and "Lower ACC".*)

The design of the airspace would involve *at most* four different ATCo positions to provide all the services, as illustrated in Figure 12. However, these positions could also be merged and be provided by fewer ATCos when the traffic load allows.

Firstly, an 'En-route ATCo' would be in charge of the En-route Area in the upper airspace region. The Approach Area would be operated by two ATCos, namely an 'Approach ATCo' and a possible 'Final Director'.

Secondly, the Approach ATCo would provide ATC in the Approach Area, that is the lower region of the airspace around the islands. This ATCo would control arriving, departing and transfer flights to and from the En-route ATCo, the Final Director, the Tower ATCo, or the Aruba (Beatrix) APP controller.

Thirdly, as in the current situation, the Planner-Coordinator would be providing coordination with adjacent centres and other regions of the airspace.

And finally, the Final Director, who is only deployed when heavy traffic loads are expected, would be in charge of sequencing aircraft that are bound for Curaçao and Bonaire airport, who would deliver aircraft to the TWR controller separated and established in the final segment of approach. Note that the Final Director would have flight responsibility, not an area responsibility.

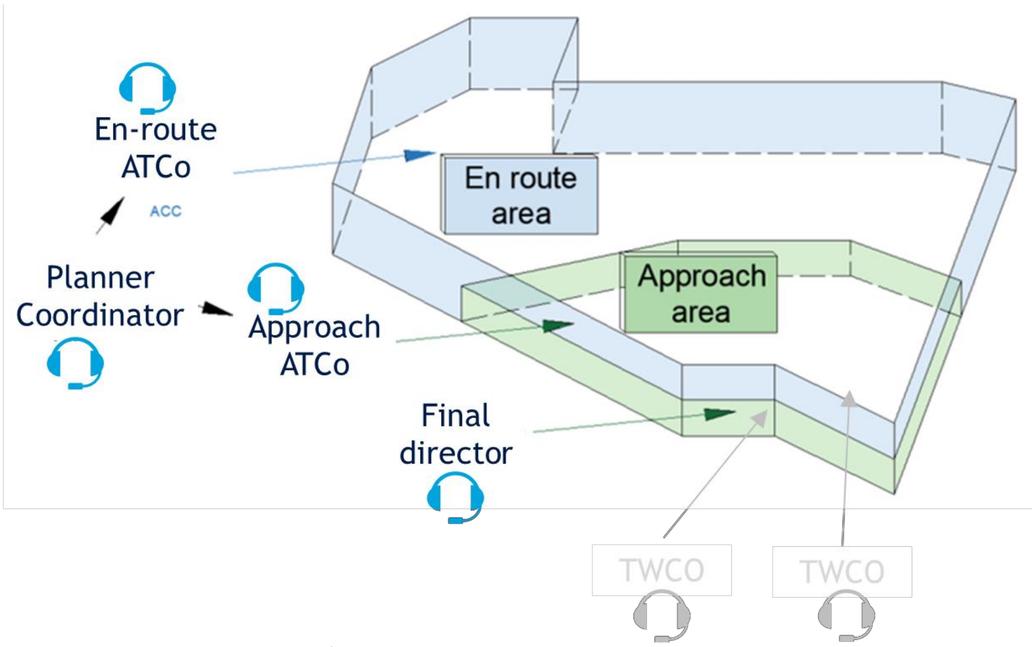

Figure 12 – Dynamic airspace use and ATCo staffing

This structure solves some of the current issues with ATCo workload. Firstly, the En-route ATCo can focus on working only in the En-route Area, instead of controlling aircraft all the way through approach handed over to TWR. The ATCo has more time to focus on en-route traffic flows, departure and arrival flow deconfliction, and thus improves safety and efficiency of the airspace.

This new structure of ATCos will be dynamic and dependent on the traffic situation. During low traffic, it will be possible to combine functions such as APP and ACC, as it done nowadays. This requires ATCos to be sufficiently trained and rated in APP and ACC.

<table>
<tr><th>Traffic load</th><th>En-route</th><th>Approach</th><th>Final</th><th>Planner coordinator</th></tr>
<tr><td>Very low</td><td colspan="4">ATCo All</td></tr>
<tr><td>Low</td><td colspan="3">ATCo All</td><td>ATCo Planner</td></tr>
<tr><td>Medium to High</td><td>ATCo
En route</td><td colspan="2">ATCo
Approach</td><td>(1 or 2) ATCo
Planner(s)</td></tr>
<tr><td>Extremely High</td><td>ATCo
En route</td><td>ATCo
Approach</td><td>ATCo
Final</td><td>(2) ATCo
Planner(s)</td></tr>
</table>

Similarly, from an airspace deployment point of view, airspace sectors will be split or merged, depending on expected traffic load. The traffic load will be monitored by the ATFM unit.

Figure 13 – Traffic demand per hour during a high-season weekend, shows the dynamics of the traffic load during the day. It also shows how the en-route traffic load changes slightly different from the traffic load to and from the three islands.

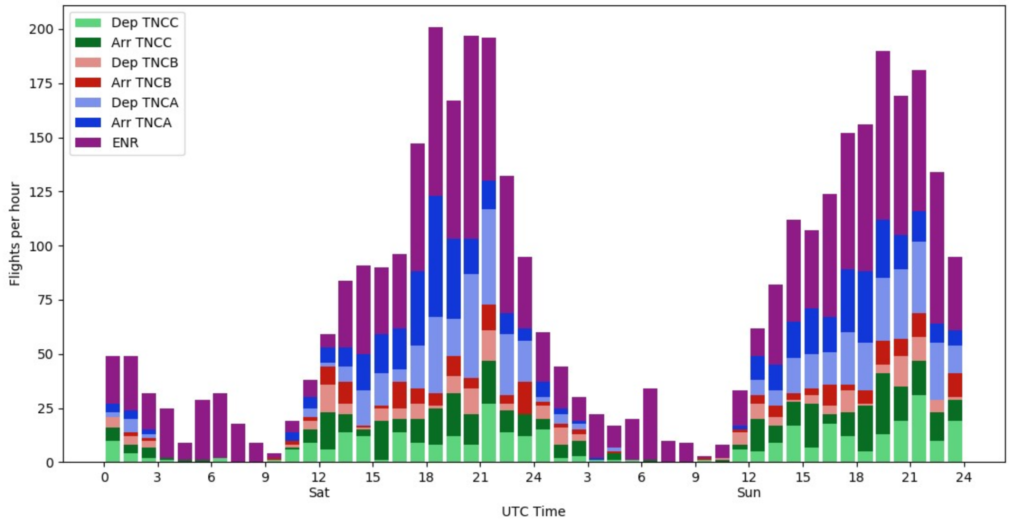

Figure 13 - Traffic demand per hour during a high-season weekend, using EFFS output data

The introduction of this structure will also involve changes to current operating procedures. Unit manuals will have to be updated to include the coordination activities and methods between the en-route and the APP controller. These coordination process could introduce new concepts for coordination such as silent coordination, which would further reduce the coordination workload.

The following specific design guidelines apply:

DG-6 ***Dynamic deployment of controllers***

Enable more efficient usage of ATCos depending on predicted traffic.

4.4 Building block 2a: “Fly as published, publish what you fly”, procedures based on actual tracks

In the current situation, ATCos usually give direct clearance to aircraft from the entry of the FIR to the IAF, or from the departure to the exit of the FIR. This means that the trajectories flown on a daily basis are not always the same as published routes. The flight trajectories vary depending on the ATCo that is active and their way of working.

Publishing procedures that support the ATCos in providing the most optimal route for the aircraft could result in ATCos working according to published procedures, resulting in a standardized traffic situation, ultimately enhancing predictability. This, combined with procedures that provide unconflicted departure and arrivals (section 4.6), would mean that minimum ATCo interaction is required for safe and efficient departures and arrivals from Curaçao and Bonaire. Given the different kinds of IFR flights to and from the islands, they can be divided in three different parts: flight departing/arriving from the north of the FIR, flights departing/arriving through the southern interface with Venezuela and Colombia, and inter-island flights.

Conventional approach charts (VOR approaches) for both Curaçao and Bonaire include a very limited number of conventional arrival routes. Given that conventional procedures will only be in place for GNSS outages or for the exceptional cases of non-RNAV capable aircraft arriving, it is proposed to keep current conventional arrival procedures.

No conventional procedures exist at the moment, so a very limited set of conventional departure routes will be designed to cater for GNSS outages and for non-RNAV capable aircraft. These conventional procedures are not required to run all the way to the FIR boundary, but rather to a point around the CTR boundary, given the limitation in the radio range of the VORs on the islands. The ATCos will then instruct flights to join the ATS route.

The following specific design guideline apply:

DG-7 ***Design routes close to actual tracks***

Actual tracks concur mostly with directs to the IAF or exit point.

DG-8 ***Procedures based on RNAV***

With a very limit number of remaining conventional SIDs and STARs for the exceptional non-RNAV flight.

4.4.1 Northern FIR SID/STARs

Northern arrival routes should be designed from the FIR entry points as straight as possible to the IAF, and northern departure routes as straight as possible from take-off to the FIR exit point. This way, not only aircraft flying direct routes (which currently happens with direct instructions provided by

ATCos), airspace users could plan their flight considering the shorter route within Curaçao FIR, with the corresponding fuel saving this involves due to the need to carry less fuel.

The publishing of only the necessary departure and arrival routes is also a factor in this building block. FIR entry and exit points that are not sufficiently used throughout the year do not require a SID or STAR. Instead the design will present the ATCo with a standardized and published work-around in the limited number of occasions where the alternate route is required. Overall, reducing the number of SIDs and STARs and standardizing them will mean a less complex operating environment.

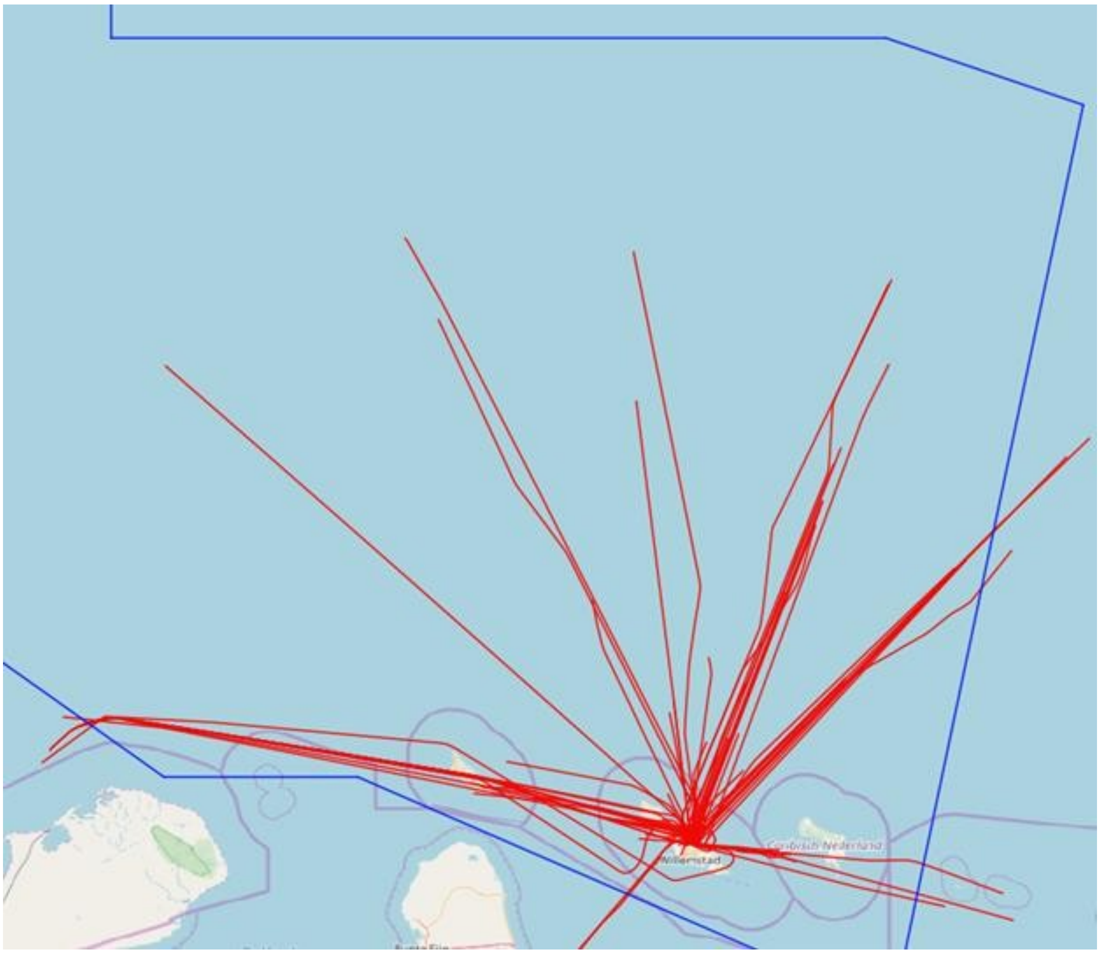

Figure 14 – Departure tracks out of Curaçao (example with limited ADS-B tracks)

4.4.2 Southern SID/STARs

In the south of the FIR, as opposed to the north, there is limited distance from the islands to the FIR boundary. This means that operations will be different, having to accommodate all flows in a small space. Given the smaller traffic load in this area than in the northern part of the airspace, the interaction between departure and arrival routes on the south is expected to be minimal. To accommodate potential future growth of southern traffic flows, arrivals will be routed as direct as possible from the FIR boundary to the IAF; always leaving 5 NM separation with the runway extended centreline. This way, the radar separation between a departure and arrival flying runway heading can be achieved by design without the intervention of the ATCos. The crossing of departure and arrival track will be placed as much as possible in positions where both flows are vertically separated. Departures will be routed from the extended runway centreline to the FIR boundary point as direct as possible as well.

4.4.3 Inter-island flights

Specific inter-island IFR procedures are proposed to be designed due to the different nature of these flights. The departure and arrival routes, as opposed to northern and southern procedures, will only go to the CTR boundaries, and they will be kept to the south of the runways so that they do not interact with the northerly traffic flows. When the departure and arrival routes need to be connected but it cannot be done on the CTR boundary (like between Curaçao and Aruba), the departure or arrival will be extended further to the other airports CTR boundary. All departures will be designed so that they can connect to an arrival to the other two islands, so that flights can file a flight plan accordingly and operate in a standard way.

4.5 Building block 2b: Publish routes for “Most of the time”

To further implement simplification of procedures, this building block aims to publish the minimum amount of procedures that will cover most of the traffic flows for the SID and STARs, to lower complexity and ATCo knowledge requirements.

Table 1 describe the most used FIR entry and exit points in 2018 for both Flamingo and Hato airports, with at least 50 flights per year.

Table 1 - Count of FIR exit and entry points of flight to and from Curaçao and Bonaire during 2018

PJB	5207	PJB	5172	PJG	5178	PJG	5211
ABA	3860	ABA	3355	ABA	764	ABA	441
ACORA	1195	ACORA	1228	VESKA	209	ACORA	253
VESKA	932	SCAPA	1042	ALCOT	194	SCAPA	247
AVELO	841	VESKA	1022	PJB	177	VESKA	202
KARUM	669	REPIS	867	ACORA	166	ALCOT	195
AMBAS	650	AMBAS	663	AVELO	119	PJB	179
SCAPA	590	KARUM	617	KARUM	102	KARUM	97
ALCOT	562	ALCOT	437	SCAPA	73	BONAX	83
BONAX	362	BONAX	397	POKAK	69	POKAK	75
DATOR	223	DATOR	189				
DIBOK	209	DIBOK	134				
BEROX	197	BEROX	122				
AMBIN	104	AMBIN	51				

The following specific design guidelines apply:

DG-9 *No routes published for rare traffic flows*

A surplus of routes impedes efficient use of the routes. In case no route is published, a standard procedure will be available how to handle this the traffic.

DG-10 *The criterium for 'rare' is 'fewer than 50 flights per year'*

The 50 flight per year criteria is established by using expert judgement, but this choice will be verified with DC-ANSP in case there is input from local operational experts.

4.6 Building block 2c: Deconfliction by design

The objective of this building block is to design departure and arrival procedures that are strategically separated from each other, i.e. in a way that the deconfliction of the aircraft on these routes is achieved by design, and the necessary ATCos actions are reduced to a minimum.

Using an ICAO defined “lateral separation” criteria as design principle, initial (within 25 NM from the airport) independent departure and arrival routes can be achieved, similar to the procedures in Beatrix Airport in Aruba. The design principle is shown in Figure 15.

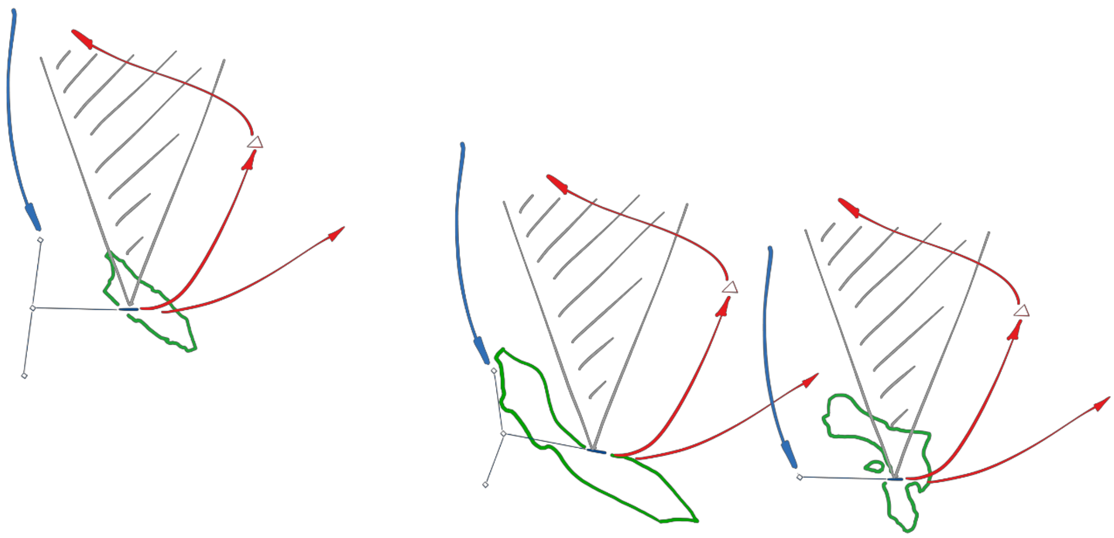

Figure 15 - Concept of the SID (red) and STARs (blue) for all three islands, with direct routes from FIR border and laterally separated as defined by ICAO and vertically conditioned by climb and descent conditions

Outside the 25NM, where routes laterally cross, vertical separation will need to be applied. Therefore, the climb and descent profiles of the departing and arriving aircraft are designed in such a way that the departing traffic will be well above the arriving traffic at the crossing point of the flight tracks. To assure this, climb and descent conditions will be published with the SIDs and STARs.

The lateral separation close to the airport in combination with these climb and descent conditions provide independent procedures that support continuous climb and descent operations.

The climb/descent conditions (FL and location) will be selected based on the flight profiles of current airspace users (Figure 16). However, since not all flights will be able to comply with the generic/average vertical profile, vertical separation will only be guaranteed by executive air traffic control when required.

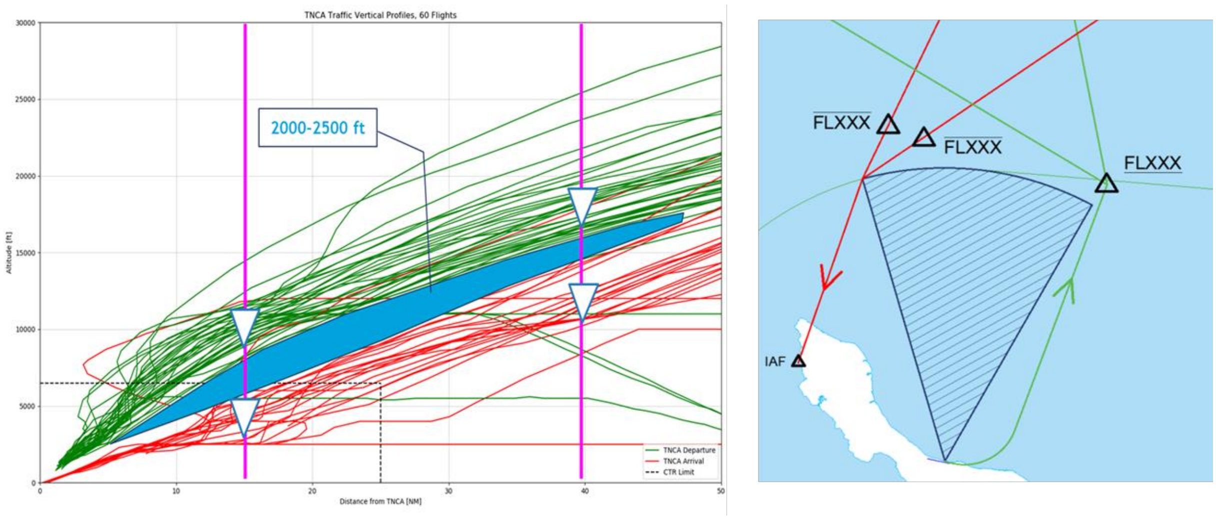

Figure 16 – Example of usage of level restriction for vertical traffic flow separation

The introduction of laterally separated design principles, however, might have the downside of making the routes longer than a direct route to/from FIR boundary. This is due to the 45-degree separation sector that needs to be in place between departure and arrival routes within 25 NM of the airport. The 45-degree sector will be positioned in such a way that the impact on the departure and arrival mileage is limited to a minimum, and is optimized for the most used routes.

Note: *This conceptual approach only applied to SIDs and STARs to/from 'the north'. SIDs and STARs to/from 'the south' will need to be separated vertically, i.e. similar to the current operations.*

The following specific design guidelines apply:

DG-11 ***Deconflicting by design using "lateral separation" principle as a tool***

DG-12 ***Place the 45 degrees lateral separation segment depending on the most used routes***

DG-13 ***Deconflict altitudes of crossing traffic***

Inbound that crosses outbound traffic will be deconflicted by altitude conditions

4.7 Building block 2d: 'Direct' routes (or routes with gates to/from Approach Area)

Building block 2a "Routes based on actual tracks" leads to a design that concurs with 'directs' to the IAF or exit point. This leads to the shortest route and expectations are that a published route will be used more by the ATCos. That is the first option for this building block.

Building block 2d also presents a second option: the use of 'gates' to and from the Approach Area. If high traffic loads so require, the 'direct' routes could be replaced by the use of gates. This will simplify flows, make controlling traffic more predictable, and allow the ACC and APP ATCos easier coordination. All arrivals from a grouped number of FIR boundary points, regardless of the destination airport, follow a route to one of the entry gates to the Approach Area boundary. At this point, the APP controller receives the flight always at the same position and based on a standardized set of transfer conditions, and flights follow a specific route to one of the airports from the entry gate. Departures are transferred in a similar way, in the opposite direction. Expectations are such that published route will be used less by the ATCos if traffic loads are not high enough.

The examples in Figure 17 show the differences between 'direct' routes and the use of gates for departure and arrival routes.

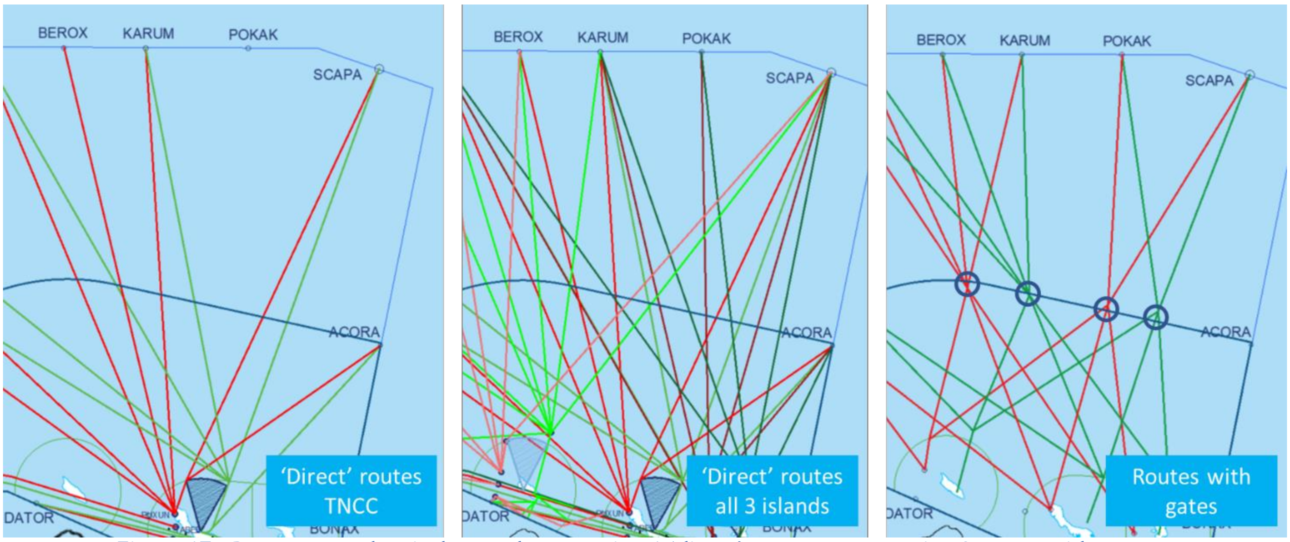

Figure 17 – Departure and arrival procedures, option 1 'direct' routes versus option 2 routes with gates

4.8 Building block 2e: Optional holding procedures

According to PANS-OPS (ICAO Doc. 8168), it is mandatory for holding procedures to be available for approaching aircraft, either on the STAR or on the instrument approach. PANS-OPS recommends the holding to be on the IAF but could be placed elsewhere if needed for operational reasons. For example, the holding could be published on a different waypoint of the arrival procedure than the IAF, or even at a waypoint that is not part of the procedure.

In the case of Curaçao and Bonaire, all instrument approach procedures currently contain holdings on the IAF/IF, meaning that the PANS-OPS requirement for having holdings is satisfied. Consequently, the new STAR designs are not required to have additional holdings.

However, at the request of DC-ANSP arrival holdings will be included in the design of the STARs to allow aircraft to hold in case there is any disruption at the airport(s). An initial thought on the locations of holdings are at TABEB (TNCC) and IMOMA (TNCB).

The following specific design guidelines applies:
DG-14 ***Design or select an IFR holding area for Curaçao and Bonaire to allow inbound traffic to hold to delay landings.***

4.9 Building block 3a: VFR routes, reporting points and optional circuit area

To address requirement Req. 4, VFR procedures will be designed in order to keep VFR traffic flows uniform within the airspace, and at the same time separate from the IFR traffic flows for an easier handling of all the traffic. The procedures will follow the same approach as applied to Aruba, where a number of VFR reporting points exist from the main arrival flows, which can be used by aircraft to join the traffic patterns. At the same time, routes will be designed for the main visual traffic flows within the FIR, such as between the islands and from the south of the FIR.

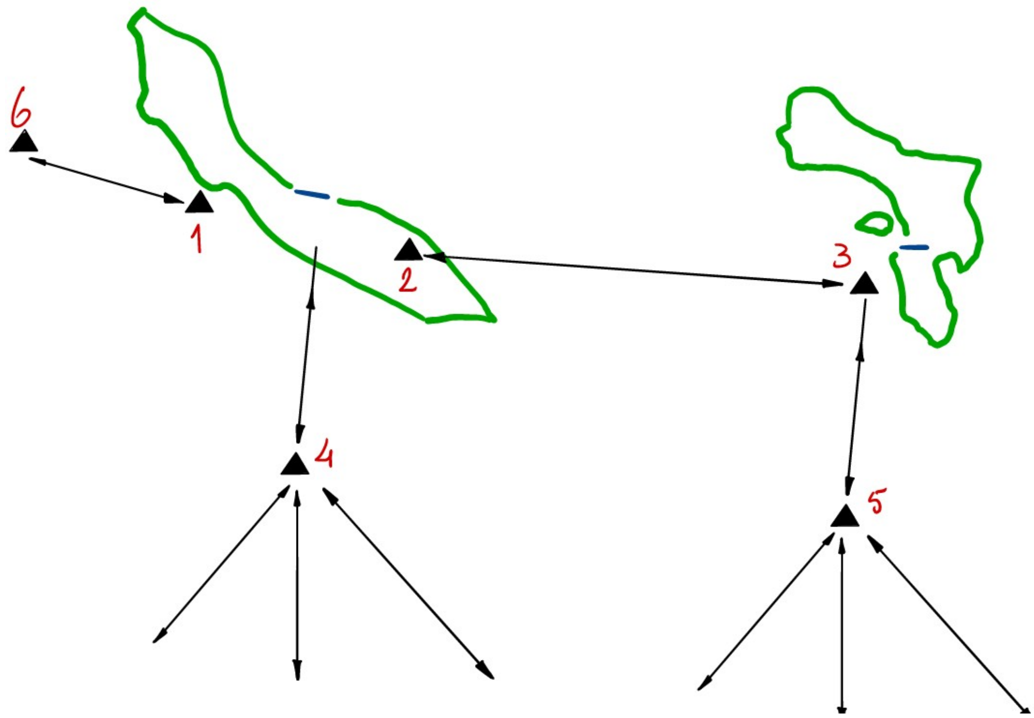

Figure 18 - Concept of VFR procedures for Curaçao and Bonaire airports

The following specific design guidelines apply:
DG-15 *Design VFR procedures strategically separated from IFR routes*
Maintain VFR traffic flows away from the main IFR traffic flows, by offsetting the routes from the runway extended centrelines.

DG-16 *Harmonize VFR procedures with those in Aruba*
Apply Aruba design considerations, in combination with the local constraints of each island, to design similar operating procedures.

4.9.1 Reporting points

At significant points of the VFR routes, such as before joining the circuit for the airfield, reporting points will be placed so that aircraft can communicate with the ATCo in a standard way. Following the preliminary design, as shown in Figure 18, six different reporting points will be placed in the VFR routes. Reporting points 1 (Curaçao west), 2 (Curaçao East), 3 (Bonaire west) and 6 (Aruba east) are placed at the ends of the inter-island routes as entry and exit points of any of the 3 airports, where aircraft will contact the TWR controller for permission to join the circuit and land in the airfield, or where they will hold before being granted permission to proceed. These points are placed to the south of the runway extended centreline, so that they remain clear of other IFR traffic that might be approaching or departing Curaçao and Bonaire airports, and will be assigned an altitude of 1,500 ft or lower. Reporting points 4 and 5 are placed approximately 8 NM south of the airfield as entry and exit points to and from Maiquetía FIR, where the routes originating in Venezuela merge into a single route to the downwind of the circuit. This way, the southern VFR traffic will be able to communicate and approach the aerodrome in a standard and timely manner, and also allow the ATCo enough time from the reporting point to the circuit to give instructions.

Reporting points:

1 – VILLAS (Off the coast from the villas in Kaap Sint Marie)

2 – KLIP or RONDE KLIP (hill called RONDE KLIP south of RWY extended centerline, recognizable hill)

3 – CRYSTAL (Crystalizers off the coast of Bonaire, in front of the salt fields of the south)

4 – SEA1 (Over the sea, 8 NM south of Hato airport)

5 – SEA2 (Over the sea, 8 NM south of Flamingo airport)

6 – SEA3 (Over the sea, 8 NM west of Hato airport)

4.9.2 VFR Routes

The standard routes will allow to keep the VFR traffic, usually slower than IFR and thus with potential to disturb IFR traffic, separated from the IFR traffic flows. The routes between the islands will be displaced to the south to stay clear of the runway and approach paths, as the runways from the islands are virtually aligned and VFR flights often fly straight in. This design will leave the approach protection areas of the runways free for IFR operations to take place, minimizing the impact to the overall operations in the Approach Area.

Besides the routes between islands, routes to the south will also be designed to accommodate the second biggest VFR flow, the Venezuelan traffic. In a similar manner to Aruba, three routes from different points in the Maiquetía FIR to the south of Curaçao and Bonaire islands will be designed, possibly based on VOR radials due to lack of visual references while over the ocean.

The concept for the VFR routes can be seen in Figure 18.

4.9.3 Circuit or circuit areas

The VFR approach procedures include a standard circuit that aircraft fly to land in the airfield. This circuit can either be of a given size (circuit), which aircraft should follow, or it can be an area that will allow the aircraft to fly any desired circuit within it (circuit area).

Figure 19 shows how the circuit area concept that was used for Aruba would fit in the current airspace of Curaçao and Bonaire. In the case of Bonaire, the circuit area would penetrate the prohibited area TNP-1, or TNP-2 if placed to the south. This means a different design will have to be used to keep VFR traffic outside the flamingo protection areas.

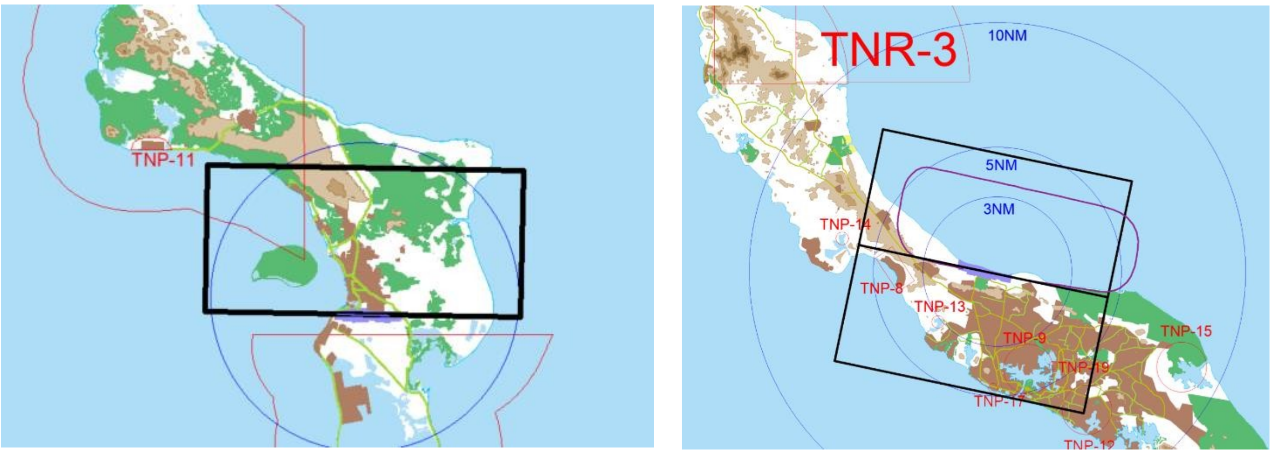

Figure 19 – Circuit area overlay in Bonaire (left) and Curaçao (right)

Figure 19 for Curaçao shows an actual flight track as an indication of a circuit size (Fokker F70 medium jet, flight JVR100, with an ATC instructed extended departure leg).

To avoid TNP-1, for Flamingo airport a VFR circuit for Light aircraft could be indicated, whereas Medium jet aircraft would require more maneuvering space than is available. For domestic commuters departing from RWY10, DC-ANSP considers a right turn after 1500ft, to fly parallel to the RWY to the SW to a VFR reporting point west of the island. To facilitate this, DC-ANSP has requested the BES authorities, to move the Northern edge of TNP-2 1 mile to the south.

4.9.4 Optional approach protection zones

To maintain VFR flights outside the runway extended centerlines, where IFR operations take place, all VFR procedures can be designed so that they remain clear of these areas. 2 NM wide approach protection areas (1 NM to each side of the runway) reaching outwards up to the IAF could further support instructing VFR flights. Figure 20 shows these areas with the proposed VFR procedures.

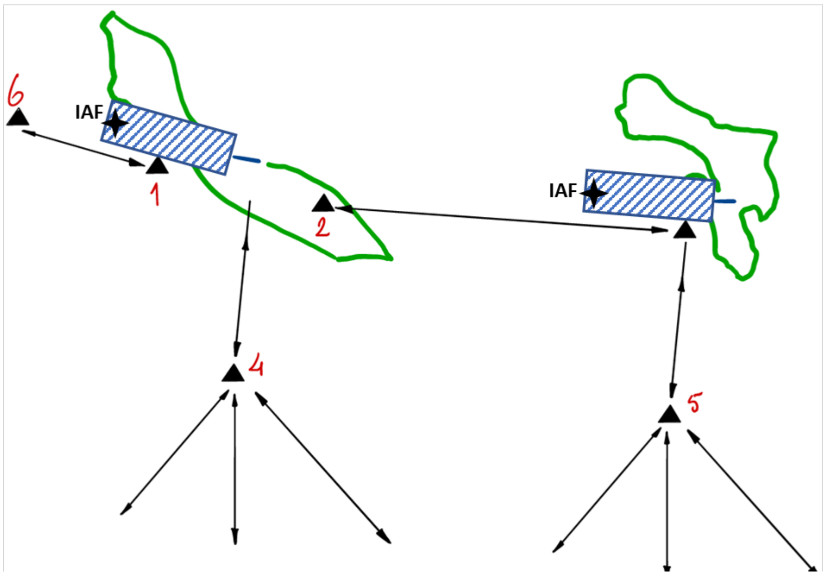

Figure 20 – VFR traffic stays clear of approach protection areas

‘Approach protection zones’ as proposed here are a means of communicating with VFR traffic. Publishing these zones makes allows to refer to the area to avoid.

5 Proposed concept and expected effects

The scope of the project is to deliver:

1. An airspace redesign/restructuring of the Curaçao Flight Information Region (FIR);
2. A route redesign of the SIDs and STARs to and from the TNCC and TNCB airports;
3. A design of the VFR procedures to and from TNCC and TNCB.

5.1 Proposed airspace redesign

The proposed solution consists of a re-sectorization of the airspace, and dynamic airspace use and staffing (Building blocks 1a and 1b). The airspace redesign of the Curaçao FIR will provide:

- Less complex operating procedures
- A structure that will better support an efficient deployment of ATCOs
- Resilient for future growth
- Improved operational safety and efficiency

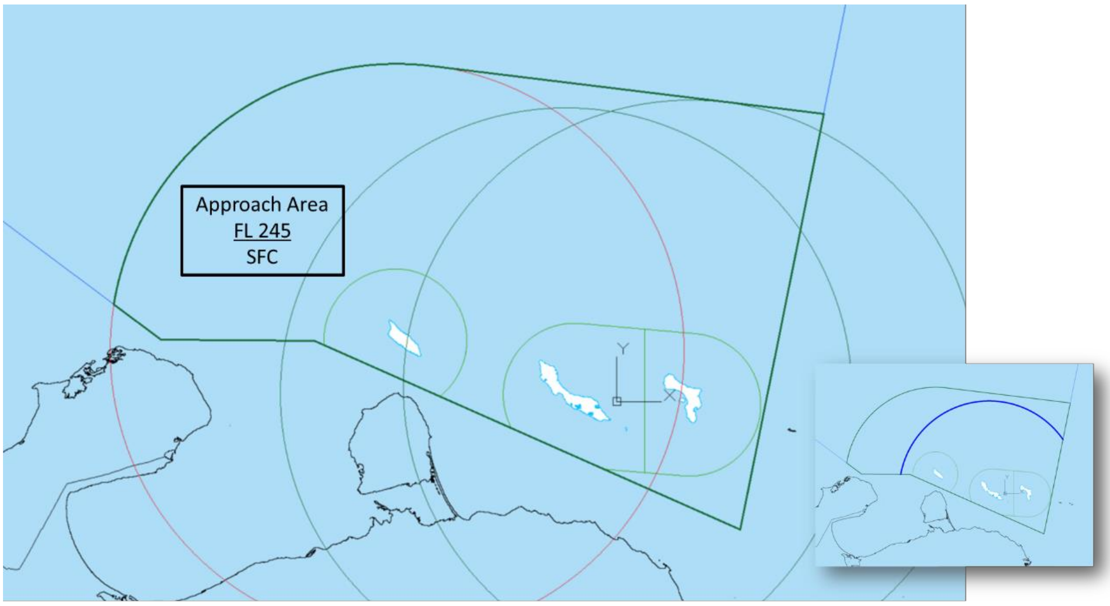

Figure 21 – Approach Area design (bold green line), insert showing current “TMA” (bold blue line)

The proposed Approach Area is shown in the picture above. It has a floor at the surface and ceiling at FL245. It is constructed from 100 NM radii from the three islands, concentric with the CTRs (Aerodrome Reference Points), to allow for sufficient room for approach control. Inbound, outbound, and inter-island traffic flows meet as much as possible in this airspace and it keeps those potential crossing conflicts clearly with Approach Control.

Traffic in this Approach Area will be controlled depending on the deployment of staff and split up of airspace, as described in Building Block 1b: Dynamic airspace use and ATCo staffing. That control will be provided by either:

(1) a single ATCo providing radar services for en-route and approach together, or
(2) a single dedicated Approach ATCo, or
(3) two ATCos: one for approach control and a second ATCo providing sequencing to the runways of Hato airport (TNCC) and Flamingo airport (TNCB).

En-route traffic will remain in the upper ACC airspace, while evolving traffic from the islands will be controlled by the APP controller below FL245. Evolving traffic from Venezuela is estimated to cross the airspace boundary above FL245, meaning flights will be in the area of responsibility of ACC.

DC-ANPS selection and naming

For the implementation of these concepts, DC-ANSP decided to have two ACC sectors:
- '**Upper ACC**', indicated in this CONOPS as the 'en-route area'
- '**Lower ACC**', indicated in this CONOPS as the 'approach area'

ATCo's are named accordingly.

DC-ANPS is reconsidering staffing of the Planner-Coordinator for future operations depending on traffic load.

DC-ANSP decided not to implement the 'Final director', as expected traffic growth does not justify such an additional controller position at this time.

5.2 Proposed SIDs and STARs design

The proposed design will provide routes for the mostly used SIDs and STARs, staying close to the actual tracks in the current situation. However, they are shaped to lower the number of potential conflicts by design. This is done by using a 45 degrees geographical segment towards the north, as shown in the figures below. This involved applying building blocks 2a, 2b, and 2c. The design has considered the inbound and outbound traffic flows for all three islands Curaçao, Bonaire and Aruba. The design philosophy and apparent resulting shape are similar. These new procedures will be RNAV.

The route redesign of the SID and STARs of Curaçao (TNCC) and Bonaire (TNCB) will provide:

- Support CCO and CDO,
- Separation of flights in and outbound from TNCC and TNCB,
- Improve operational safety and efficiency for ANSP and airspace users

A limited number of conventional procedures still need to remain for non-equipped aircraft and GNSS outages. For this reason, it is proposed to preserve the existing VOR STARs, and to design a very limited number of VOR SIDs to the boundary of the CTR.

5.2.1 Northern procedures

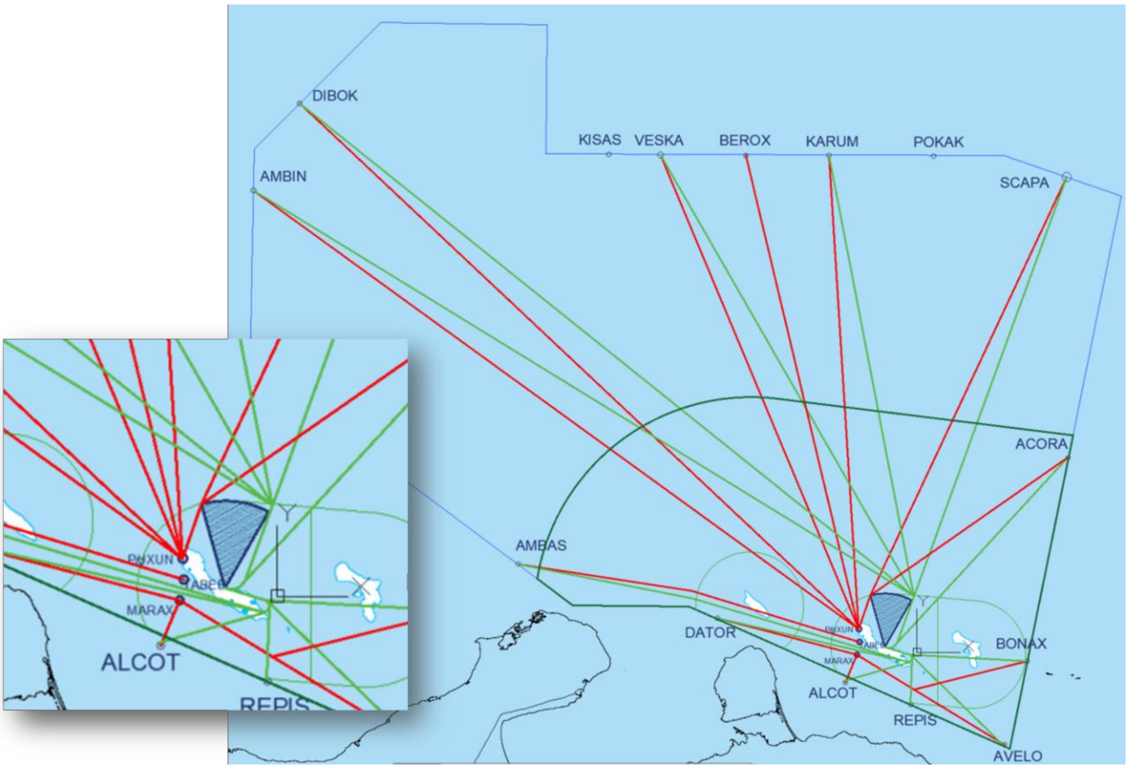

Figure 22 – Proposed SID and STARs for Curaçao

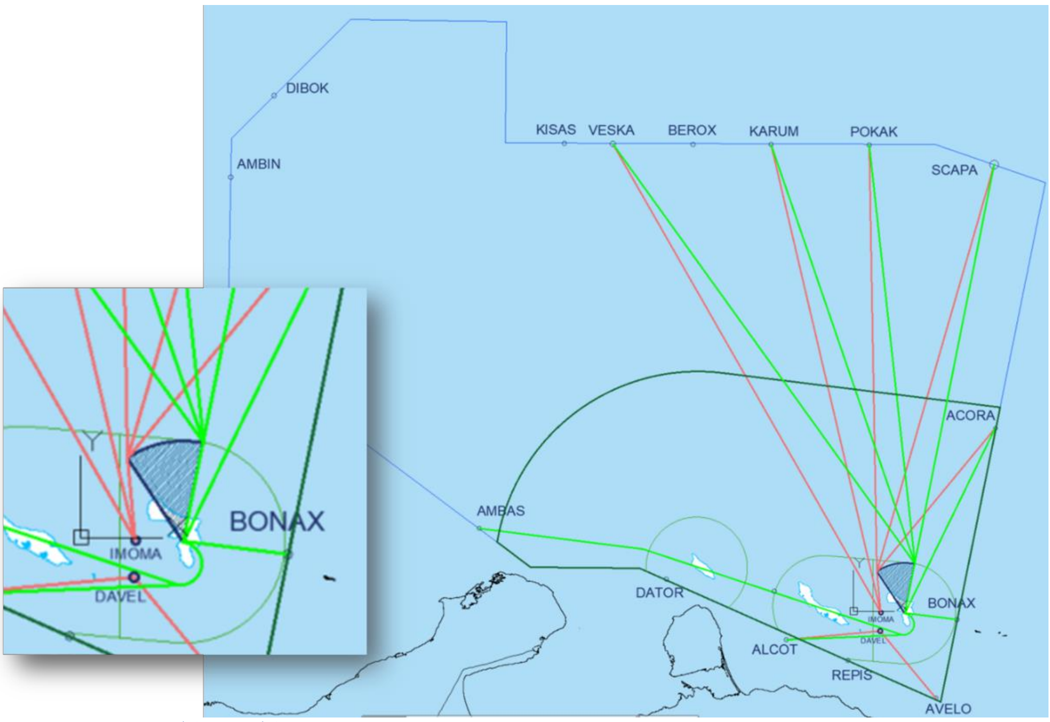

Figure 23 – Proposed SID and STARs for Bonaire

Procedures are proposed for all FIR boundary points having more than 50 flight per year. These procedures are proposed to be designed using the 45-degree sector north of the airport, as described by the lateral separation concept, so that departure and arrival flows are kept separate. With the introduction of level restrictions around the CTR boundary, the SID and STARs are separated by design.

The option for ‘gates’ will not be used in the design, as the traffic load in the TNCF airspace does not require it. Instead routes will be based on ‘direct’ connections.

5.2.2 Southern procedures

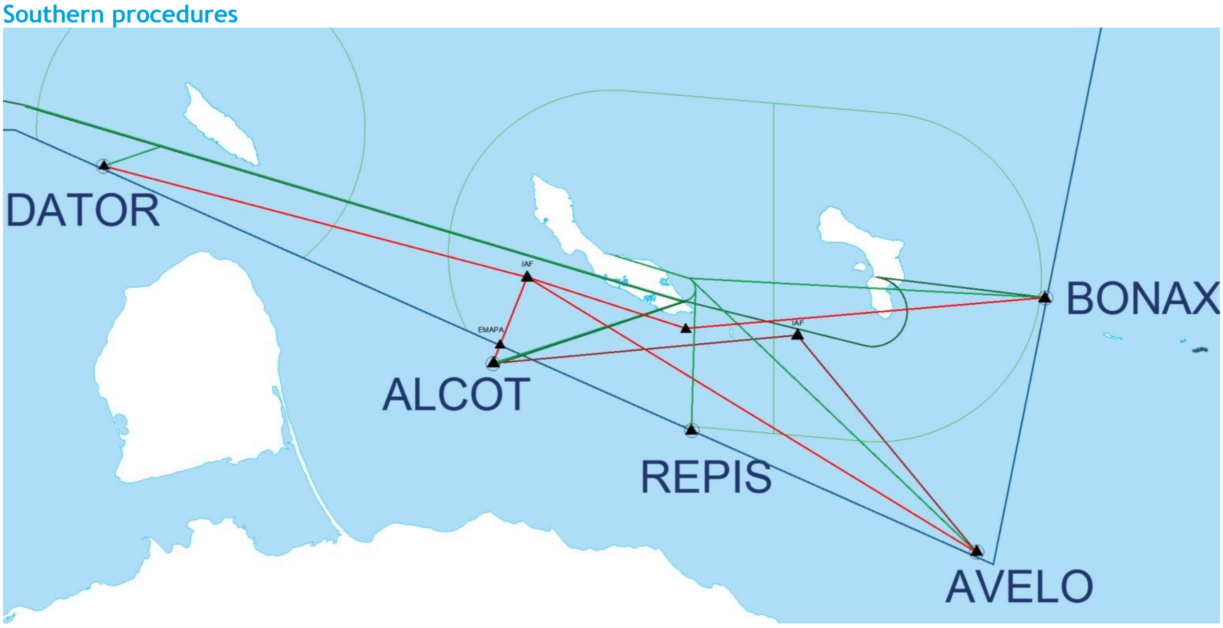

Figure 24 – Procedures to and from southern FIR boundary points

Southern procedures are proposed as described in section 4. Due to the lack of space, the procedures cannot be designed following the same approach as for the northern sector. In this case, given that the traffic flows are not as large as in the north, the procedures are designed as direct as possible from FIR boundary to IAF while trying to keep a distance of at least 5 NM (radar separation minimum within the approach area) between runway extended centreline and arrivals.

One consideration that should be taken into account in the design phase of the SID and STARs is the location of boundary point ALCOT. This waypoint is geographically located in Venezuelan territory, designing procedures starting or ending in foreign airspace might bring issues. For this reason, waypoint EMAPA (at a similar geographical location, but in the FIR boundary) could also be considered for the design of procedures.

5.2.3 Inter-island procedures

The inter-island procedures are designed as described in section 4.4.3. The departure and arrival routes of Bonaire and Curaçao are designed so that they connect to the ones in Aruba airspace.

The southern routes depicted in Figure 25 will be used in the inter-island traffic flows. This way, all arrivals coming from the south-east will be grouped into one single flow. Given that the traffic volume entering the FIR in the south-east is not very large, the interaction between those flights and the inter-island flights will be minimal.

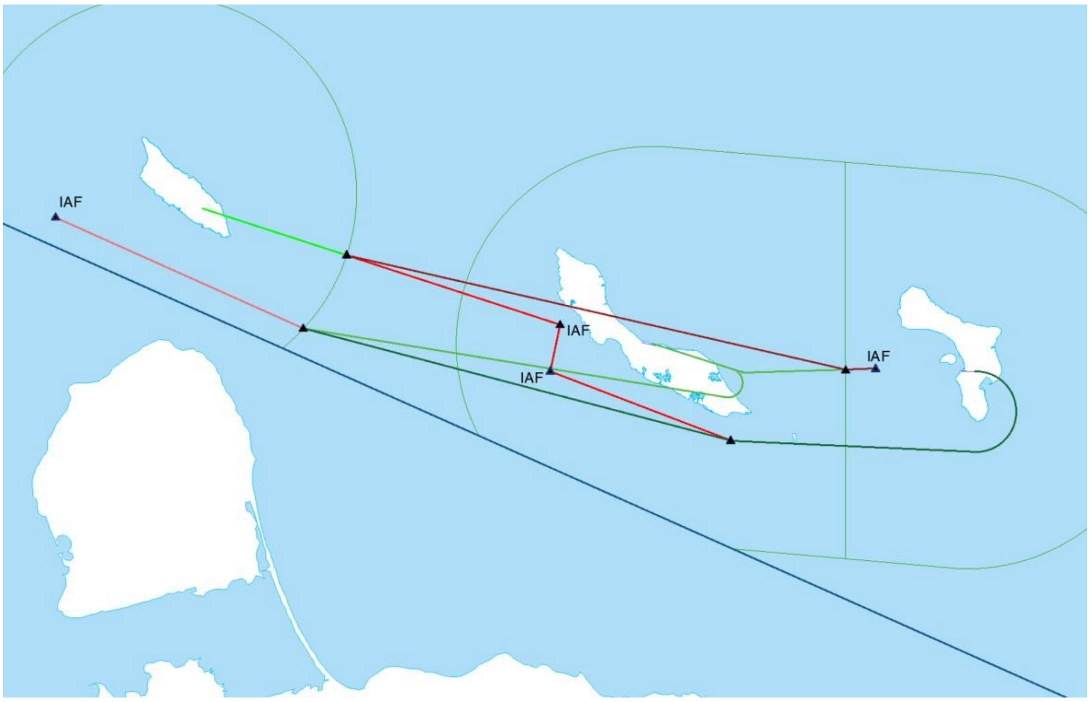

Figure 25 – Inter-island IFR procedures

5.3 Proposed VFR procedures

The design of VFR procedures for Curaçao (TNCC) and Bonaire (TNCB) will provide:

- More strategically separated traffic based on established procedures
- Optimization of routes between Curaçao (TNCC), Bonaire (TNCB), and Aruba (TNCA)
- Improve operational safety and efficiency

The proposed VFR procedures are shown in Figure 26. The VFR reporting points and routes are placed to the west and east of the aerodrome, south of the runway expended centreline.

For Curaçao, a traffic circuit area is proposed to the south of the field, which would accommodate all types of VFR traffic (large or small aircraft). Another traffic circuit area is also proposed to the north of the field, over the sea, but is kept as a secondary zone that can be used at ATCo’s discretion. This way, the VFR traffic is kept separate from the northern IFR traffic flows.

For Bonaire, a traffic circuit is proposed due to lack of space to fit a circuit area. This circuit will be for light aircraft that can maneuver within this circuit, and the larger aircraft will have to operate as indicated by the ATCo.

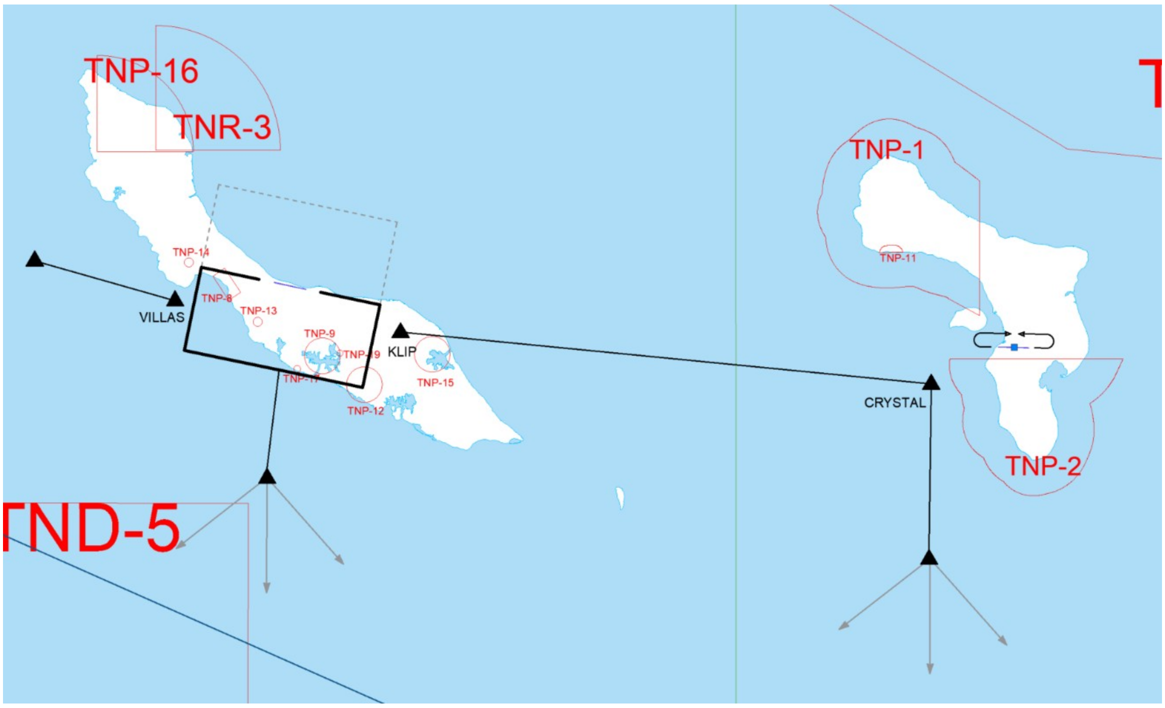

Figure 26 – VFR procedures for Curaçao and Bonaire

5.4 Expected effects from Operational Concept

The redesign of the routes and airspace aims to meet the requirements as explained in section 3 “Requirements for the new design”:

- **Req. 1.** Balance the workload of the ATCOs in Curaçao’s, by means of re-sectorization;
- **Req. 2.** Simplify the traffic flows by deconfliction and standardization;
- **Req. 3.** Improve flight efficiency by supporting continuous climb and descent operations.
- **Req. 4.** Standardize VFR procedures and separate VFR and IFR flows by design
- **Req. 5.** ICAO compliant procedures and naming

The expected effect of the ‘Re-sectorization’ and the ‘Dynamic airspace use and ATCo staffing’ based on traffic demand is rebalancing of the workload, leading to a reduction of the peak workload for all ATCos.

Adhering to ‘Fly as published, publish what you fly – procedures based on actual tracks’ is expected to lower the workload for the ACC and APP controllers and bring more fuel-efficient operations.

The expectation of the ‘Deconflicted routes’ is twofold. By itself it will reduce complexity and therefore workload for the approach and en-route controllers. It will also allow an undisturbed descent and climb (CCO/CDO), even when traffic is busy. CCO/CDO’s make flight operations more fuel efficient.

The newly introduced VFR procedures will make (inter-island) VFR flights more predictable, thus lowering the workload for the approach and aerodrome controller. More predictable routes also reduce the number of times VFR flights are instructed away from the planned route, a situation local carriers like to avoid as much as possible.

Abbreviations and key terminology

	Alternative wording	Remarks
A-Controller	Curaçao ACC Assistant Controller; FDP; Flight Data Position	-
Approach Area	TRACON; TMA; Lower ACC	The current corresponding ATC units are 'Curaçao ACC' and 'Hato Radar' with call signs Curaçao Control' and 'Hato Approach'.
ATZ	Aerodrome Traffic Zone	The dimensions and the function of the ATZ's very much concur with CTR's in other parts of the world. The *current* corresponding ATC units are 'Hato Tower' and 'Flamingo Tower'.
CTR	Control Zone (around airport)	The dimensions and the function of the CTR's very much concurs with TMA's in other parts of the world. The *current* corresponding ATC units are 'Hato Radar', 'Hato Tower' and 'Flamingo Tower'.
D-Controller	Curaçao ACC Decision Controller; Executive Controller	-
En-route Area	Curaçao Control; ACC; Curaçao Radar	The current corresponding ATC unit is called 'Curaçao ACC' with call sign 'Curaçao Control'.
Final director	-	Optional position, to consider if very heavy traffic loads develop in the future. This ATCo would be in charge of sequencing aircraft in the final segment of approach.
Hato Radar Controller	-	This ATCo provides approach control services in the Approach Area and two CTR's.
TWCO	Tower Controller	-

References

a. International Civil Aviation Organisation (ICAO): *Doc 8168 – Procedures for Air Navigation Services - Aircraft Operations (PANS-OPS)* and *Doc 9906 Vol. 5 – Validation of Instrument Flight Procedures*

b. Unit Manual Curaçao ACC, DC-ANSP, December 24th, 2018

c. Unit Manual Hato Radar, DC-ANSP, December 24th, 2018

d. Unit Manual TWR Hato, DC-ANSP, December 24th, 2018

e. Unit Manual TWR Flamingo, DC-ANSP, December 24th, 2018

f. Aeronautical Information Publication (AIP), AMDT 04-19

g. Aeronautical Information Circular (AIC) 10/19 – *Implementation of Space Based Automatic Dependent Surveillance-Broadcast (ADS-B Space Based) in the Curaçao (TNCF) FIR*

h. Aeronautical Information Circular (AIC) 07/19 – *ADS-B Mandate Eff. 01 Jan 2020*

i. Letter of Agreement (LoA) – *San Juan ACC, Kingston ACC, Maiquetía ACC, Port-au-Prince ACC, Santo Domingo ACC, Barranquilla ACC, ANSA*

j. Proposal airspace restructuring v0.1.8, May 22nd, 2019

k. Mn2019_ concept of Operations_v1.5Final, April 17th, 2019

l. 19-RA-019 – Safety Case Space-based ADS-B v1.0, July 19th, 2019

Document control

Version	Date	Author	Pages	Changes
0.01	12-11-2019	Okina/Lentze	All	First draft
0.02	14-11-2019	Okina, Lentze	All	Internal review Van der Plaat, Waltman
0.03	18-11-2019	Okina, Lentze	All	Internal review The, Koeslag, Jester
0.04	29-11-2019	Okina, Lentze	All	Internal review by Ruis. Partial internal review by Van der Plaat and Waltman
0.05	16-12-2019	Okina, Lentze	All	Draft version for DC-ANSP review.
0.06	10-01-2019	Okina, Lentze	All	Internal review by Jester, Hertfelder
0.07	23-01-2019	Okina, Lentze	All	All proposed review comments processed for approval
1.0	17-07-2020	Lentze	All	All DC-ANSP (Ethier) review comments processed
1.1	24-08-2020	Lentze	All	Additional DC-ANSP (Lasten, Spong) review comments processed
1.2	14-09-2020	Lentze	All	Additional DC-ANSP (Lasten, Albertus-Verboom) review comments processed
2.0	16-09-2020	Lentze	6, 8	Additional DC-ANSP (Lasten) review comments processed

Distribution

Name	Organization
Jacques Lasten	DC-ANSP

Annex A New Approach Area horizontal limits

Name & Limits	Unit providing service	Callsign	Frequency	Remarks
CURAÇAO APPROACH AREA Area bounded by lines joining points: 13 40 35.04N/67 29 32.28W; 14 08 35.04N/69 40 03.72W; along the counter clockwise arc of a circle of 100 NM radius centered on 12 30 05.82N/70 01 14.79W (VOR/DME BEA); 12 42 39.60N/71 42 37.08W; 12 30 00.00N/71 25 00.12W; 12 30 00.00N/70 30 00W; 11 24 00.00N/67 58 00.12W to point of origin	Curaçao APP	TBD	TBD	Completion in design phase