Concept of Instrument Flight Procedures

Brasov International Airport

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Executive Summary

The Concept of Instrument Flight Procedures (IFPs) is an addendum to the Conceptual Airspace Note, reference CPJ-5531-DOC-015 V1.1, dated 21 October 2020. This document considers the airspace and associated IFPs following stakeholder engagement on the Conceptual Airspace Note.

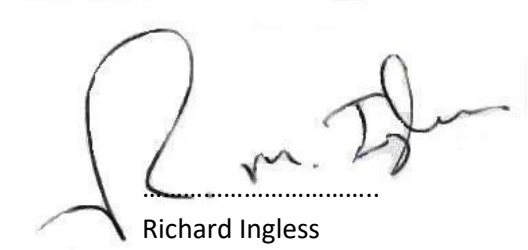
This report considers the limit of the Brasov Controlled Zone (CTR) and the airspace considerations to joining the IFPs to the Air Traffic Services (ATS) route network. The main factor to the design of the IFPs was to limit the impact to the surrounding airspace. It must be noted that the two main constraints to developing the airspace and associated IFPs is the surrounding mountainous terrain and the adjoining restricted airspace. It is evident that compromise to operational performance and flexible use of airspace is required for Brasov International Airport (BIA).

It has not been possible to propose concept designs for conventional procedures using the ground-based navigational aids as the site for these had not been decided during the development of this proposal. In addition, a conventional Missed Approach Procedure for the Instrument Landing System (ILS) was not developed. Instead, it is proposed that the MAP replicate the Standard Instrument Departures (SIDs) to join a hold on the selected ATS Route, this facilitates aircraft repositioning if required to divert. Based on known weather (fog) conditions at Brasov, it is unlikely for aircraft to hold indefinitely for the fog to lift in the event that an approach is not possible. Aircraft carry limited fuel reserves that allow for a limited number of attempts to conduct an approach and holding.

The ILS CAT II IFP concept design represents the lowest achievable minima of the available suite of IFPs. Required Navigation Performance (RNP) designs are possible but current criteria for LPV200 designs will at best achieve the equivalent capability of ILS CAT I minima (obstacle field permitting). Whilst other RNP designs are possible there is insufficient feedback from operators to indicate the likelihood of these procedures being possible, an example of this is RNP-AR. As such, this document represents what is achievable based on feedback from operators.

The proposal determines that a CTR, with an IFP infrastructure is feasible. It is evident that an ILS CAT II approach to Runway 22 is also feasible but there are constraints to achieve a reasonable Obstacle Clearance Altitude (OCA). To ensure all users are able to access airspace on a requirement basis that Flexible Use of Airspace is implemented. Additional use of Letters of Agreement or memorandums of Understanding are also considered.

John van Hoogstraten
Operations Director



Richard Ingless
Head of Engineering

Abbreviations

ARP	Airport Reference Point
ATS	Air Traffic Services
BIA	Brasov International Airport
CAT	Category
CDO	Continuous Descent Operations
CTR	Controlled Zone
DA/H	Decision Altitude/Height
DER	Departure End of Runway
DF	Direct to Fix
ETOD	Electronic Terrain and Obstacle Data
FAP	Final Approach Point
IAF	Initial Approach Fix
IAP	Instrument Approach Procedure
IFP	Instrument Flight Procedure
ILS	Instrument Landing System
MACG	Missed Approach Climb Gradient
OCA/H	Obstacle Clearance Altitude/Height
PDG	Procedure Design Gradient
RNP	Required Navigation Performance
RWY	Runway
SID	Standard Instrument Departure
STAR	Standard Terminal Arrival Route
THR	Threshold
TRA	Temporary Reserved Area

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1. Introduction

1.1. Background

1.1.1. A new international airport is under development at Brasov in Romania. A Concept of Operations[1] (CONOPs) for the provision of Air Traffic Services has been proposed for Brasov International Airport (BIA). In addition to the CONOPs, a 'Conceptual Airspace Note'[2], was developed to establish the concept for the airspace and the Instrument Flight Procedures (IFPs) to be contained within it.

1.1.2. In discussion with ROMATSA, it was agreed that the purpose of the Concept Airspace Note was to understand the constraints of design. i.e. Upper Airspace Route network and En-Route criteria. Consequently, the Concept Airspace Note represents an 'ideal' design without fully considering the associated airspace restrictions.

1.1.3. The Concept Airspace Note was used to develop the proposed Instrument Flight Procedures (IFPs) and Airspace Concept described in this document. This report is an addendum to the Concept Airspace Note[2].

1.1.4. Following discussion with the Romanian Military authorities, this document has been further developed to include additional routes to the north and south of BIA. The purpose of the additional routes is to minimise the impact to the military training and restricted airspaces. Rather than provide two solutions, it was determined that additional routes would complement the previously provided Instrument Flight Procedure (IFP) concepts and allow greater flexibility for all stakeholders.

1.2. Purpose

1.2.1. This report considers the adjoining airspace and terrain constraints. It describes a design compliant with PANS-OPS design criteria and considers stakeholder requirements to minimise the impact to adjoining restricted and training areas. Where possible the IFPs are contained within with the Brasov Controlled Zone (CTR).

1.2.2. Design constraints mean penetration of portions of the adjoining airspace is unavoidable. At meetings with the stakeholders, it was agreed that compromises with the wider airspace user community will be required. This Proposal enables stakeholders to assess the proposed compromises and provide review comments. It is anticipated that following receipt of stakeholder reviews, the concept design may require amendment or clarification.

1.2.3. This report does not draw any conclusions but represents a proposal for Brasov Airport based on known constraints and input from stakeholders.

[1] CPJ-5531-DOC-014 'Concept of Operations – Brasov International Airport'
[2] CPJ-5531-DOC-015 'Conceptual Airspace Note – Brasov International Airport'

1.3. Concept Airspace Design

1.3.1. This Proposal consists of the following elements:

- Controlled Zone (CTR)
- Standard Instrument Departures (SIDs)
- Standard Terminal Arrival Routes (STARs)

2. Assumptions and Constraints.

2.1. Assumptions

2.2. The following assumptions have been made:

- Provision of Procedural Air Traffic Control owing to insufficient surveillance coverage to provide positive Approach Control.
- There will be only one Instrument Landing System (ILS) and will be provided for Runway (RWY) 22.
- There is no requirement for a Non-Directional Beacon (NDB) however, a VHF Omni-Directional Range (VOR), with associated Distance Measuring Equipment (DME), will be installed on the Airport.
- Performance Based Navigation (PBN) and VOR/DME procedures to both runway ends are required to complement the ILS procedure to RWY 22.
- The SIDs and STARs should link the Airport to RNAV ATS Routes L620, L850, Z650 and M747.
- A Signal in Space (SiS) assessment will be conducted by the ANSP.
- The ANSP will be responsible for having a signed Working Agreement with European Geostationary Navigation Overlay Service (EGNOS) and for monitoring SiS outages.

2.3. Constraints

2.3.1. The following constraints have been identified:

- **Terrain:** The mountainous terrain in the area surrounding the Airport (particularly to the South and South-West) is a significant constraint to the design of the IFPs. In some instances, the Minimum Obstacle Clearance Altitude (MOCA) is increased to 2,000ft mountainous areas limiting the art of the possible and reducing the potential for multiple options for design.[3]
- **Airspace Restrictions:** The large amount of airspace already reserved as 'Restricted' or 'Danger' Areas constrains the amount of unrestricted airspace to a point that it is not possible to design IFPs to serve the Airport without entering such an area. The nominal track and/or primary/secondary areas must penetrate these areas and as such there will need to be consultation with the parties affected by such proposals.
- **Immediate Surroundings:** The proximity of the runway at Ghimbav Aerodrome, the operations from Sanpetru Aerodrome and the HLSs will require consideration in the development of the designs and ATS procedures.

[3] Romanian AIP (GEN 3.3-2, Section 5): The minimum flight altitude on ATS routes, presented in section ENR 3, has been set so as to ensure a minimum safety height of at least 300m (984ft) above the highest obstacle in the area considered. Into the mountainous areas the minimum safety height will be increased, depending on the variation of the terrain: a. 600m (1969ft) for areas with a terrain elevation variation greater than 1500m (5000ft); b. 450m (1476ft) for areas with a variation in elevation between 900m (3000ft) and 1500m (5000ft). Mountainous areas are represented by areas where the terrain profile is variable and where elevation variations the terrain exceeds 900m (3000ft) over a distance of 10NM (18.5km). Note - The accuracy of the navigation performance required for operation on air routes in FIR BUCHAREST is expressed by the RNP type. The RNP type is a value of framing in the width of the airway, expressed as a distance in NM from the intended position in which at least 95% of the total flight time takes place. For operation on the air routes from FIR BUCHAREST, the RNP value is 5 (five).

- **Environmental Considerations:** The large number of environmental areas that should be considered (Natura 2000) combined with the need to avoid, as best as practicable, the built-up areas, adds a further complexity to the picture to a point that it may not be possible to design IFPs to serve the Airport without overflying such an area. It may be that the nominal track and/or primary/secondary areas must penetrate these areas and as such there will need to be consultation with the parties affected by such proposals.
- **Surveillance Coverage:** The absence of sufficient surveillance coverage limits the Approach Control service to a procedural service (APP). The inability to provide a positive Approach Control service using surveillance (APS) reduces the likelihood of being able to achieve both Continuous Descent Operations (CDOs) and Continuous Climb Operations (CCOs). Furthermore, the inability for Air Traffic Control (ATC) to monitor an aircraft's position means that an RNAV 1 specification is inappropriate and an RNP-1 specification (with the inherent on-board performance monitoring and alerting).
- **Circling:** The requirement to limit circling to the North-West of the Airport is assumed to be related to the terrain constraints and a desire to reduce the noise impact on the built-up areas of Brasov.

3. Airspace

3.1. Airspace Layout

3.1.1. The airspace has been designed with a Controlled Zone (CTR) surrounding BIA with IFPs linking to the En-route network.

3.1.2. The Brasov CTR is 8NM either side of the extended runway centre line with a 16NM radius arc around the Airport Reference Point (ARP). The CTR extends from surface to Flight Level (FL) 105.

3.1.3. Figure 1 provides an overview of proposed Airspace configuration.

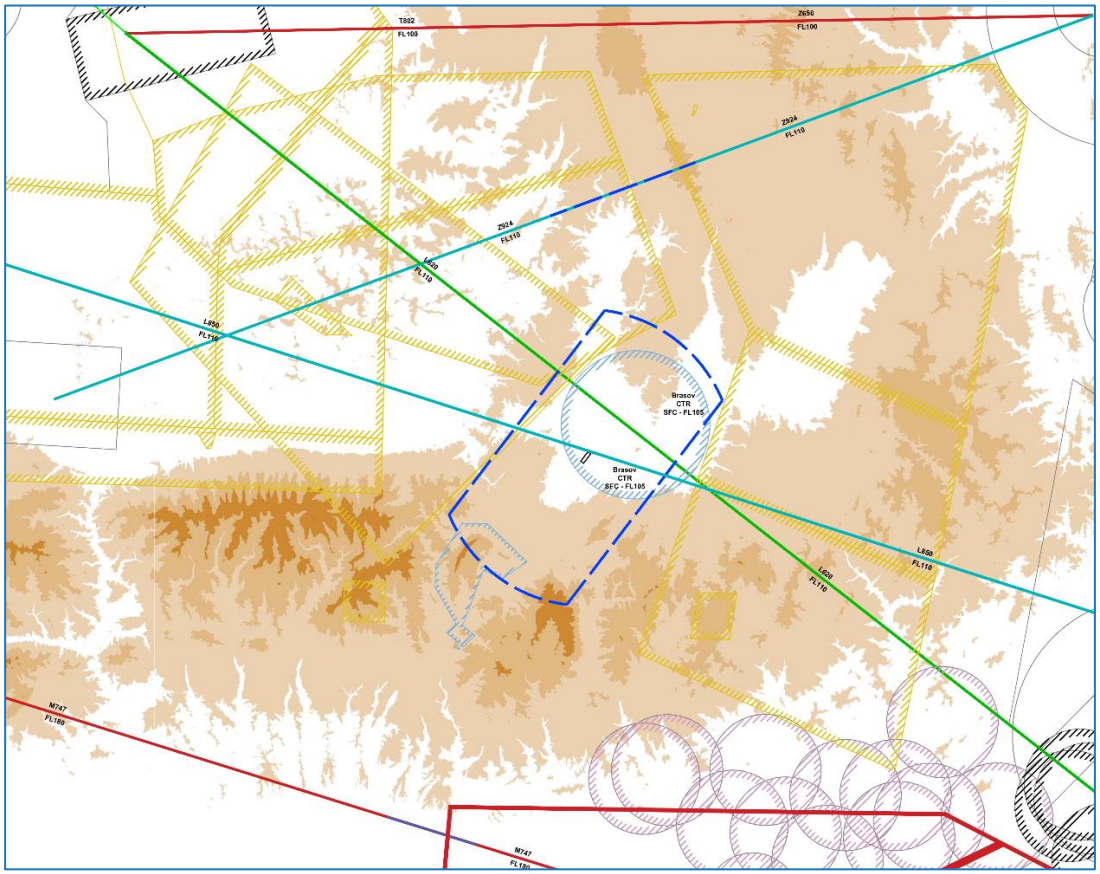

Figure 1: Proposed Airspace Configuration

3.2. Impact on existing Airspace

3.2.1. The design process ensured measures were taken to minimise the impact (overlap) of adjoining airspace. The only exception is LRD102 as this airspace is located very close to BIA and therefore mostly contained within the CTR.

3.2.2. The CTR marginally overlaps Temporary Reserved Area (TRA) 73A (LRTRA73A) and Danger Area 10 (LRD10).

3.2.3. The SIDs and STARs to each runway are presented in Section 4 for Runway (RWY) 04 and Section 5 for RWY 22.

3.2.4. Track distances are provided for SIDs and STARs in the Tables for each respective runway.

3.2.5. With respect to the SIDs, the distance is from the Departure End Runway (DER) to the associated ATS route.

3.2.6. STARs are calculated from leaving the ATS route until the Initial Approach Fix (IAF) prior to joining the Instrument Approach Procedure (IAP). An aircraft will then intercept the IAP for the applicable runway, resulting in an approximate additional distance of 15NM to the Runway threshold (THR).

4. Runway 04

4.1. Overview

4.1.1. An overview of the proposed SIDs and STARs for RWY 04 operation is depicted in Figure 2, showing the nominal tacks and entry exit points along the en-route, for the SIDs and STARs. As BIA is intended to operate with procedural control, all SIDs and STARs have been constructed to Required Navigation Performance (RNP) Criteria.

4.1.2. The track miles for the configuration of the SIDs and STARs are shown in

Procedure	Track Mileage
SID RWY 04 L620	80NM
SID RWY 04 L850	51NM
SID RWY 04 Z650	53NM
STAR RWY 04 L620	20NM
STAR RWY 04 L850	42NM
STAR RWY 04 M747	27NM

4.1.3. Table 1 and consider the distance to or from the ATS route network.

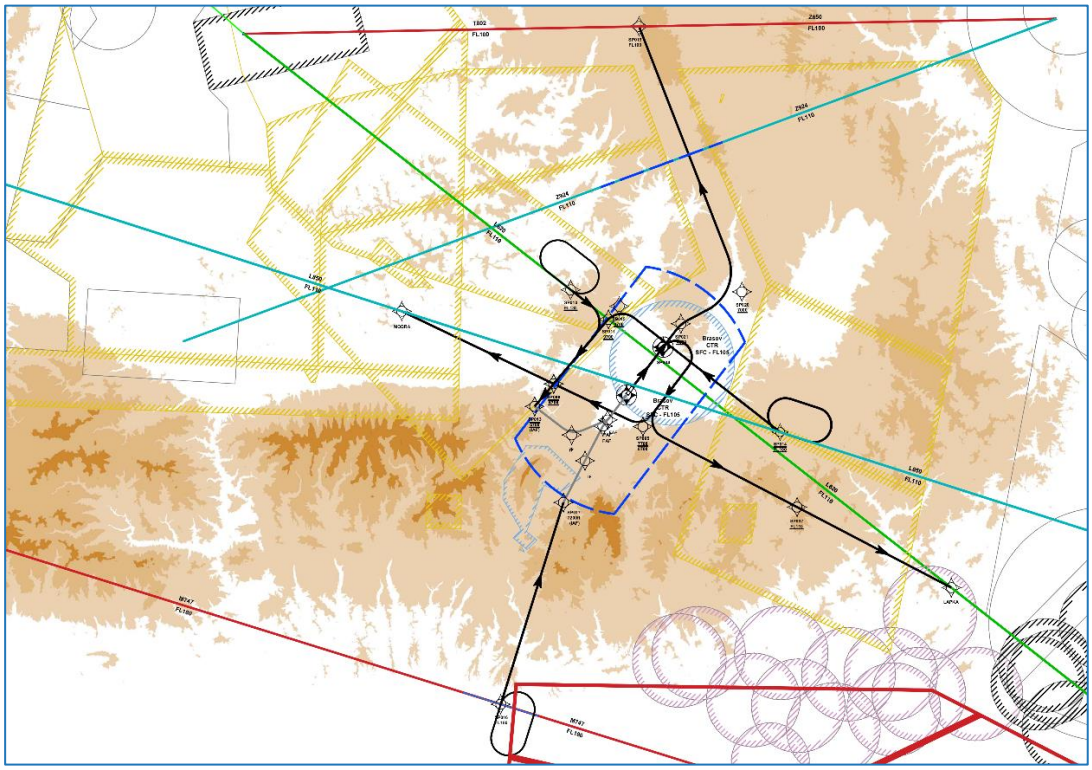

Figure 2: RWY 04 Operations SIDs / STARs

Procedure	Track Mileage
SID RWY 04 L620	80NM
SID RWY 04 L850	51NM
SID RWY 04 Z650	53NM
STAR RWY 04 L620	20NM
STAR RWY 04 L850	42NM
STAR RWY 04 M747	27NM

Table 1: Runway 04 Procedures Track Miles

4.2. Standard Instrument Departures

4.2.1. The SIDs have been designed to reduce the required volume of airspace to support BIA operations. By keeping the nominal track within the CTR the majority of climb can be achieved within proximity of the Airport. To keep the arc radius of each turn to a minimum, the procedures have been limited to 210kts, with a minimum bank angle of 25°. Due to the high terrain to the south, a minimum Procedure Design Gradient (PDG) of 7% was used for construction.

4.3. Westbound Departures (L850)

4.3.1. As depicted in Figure 3, aircraft departing RWY 04 to join ATS route L850, climb out on RWY heading, before performing a right turn at a flyover waypoint (SP004), then on a Direct to Fix (DF) leg to a fly-by waypoint (SP005), with an altitude restriction window of 7700ft to 8700ft. Due to the arrivals onto RWY 04, a fly-by waypoint (SP006) is placed it ensure aircraft on the departure remain separated from aircraft passing on the arrival below.

4.3.2. The SID ends linking to the lower En-Route structure at waypoint MOBRA.

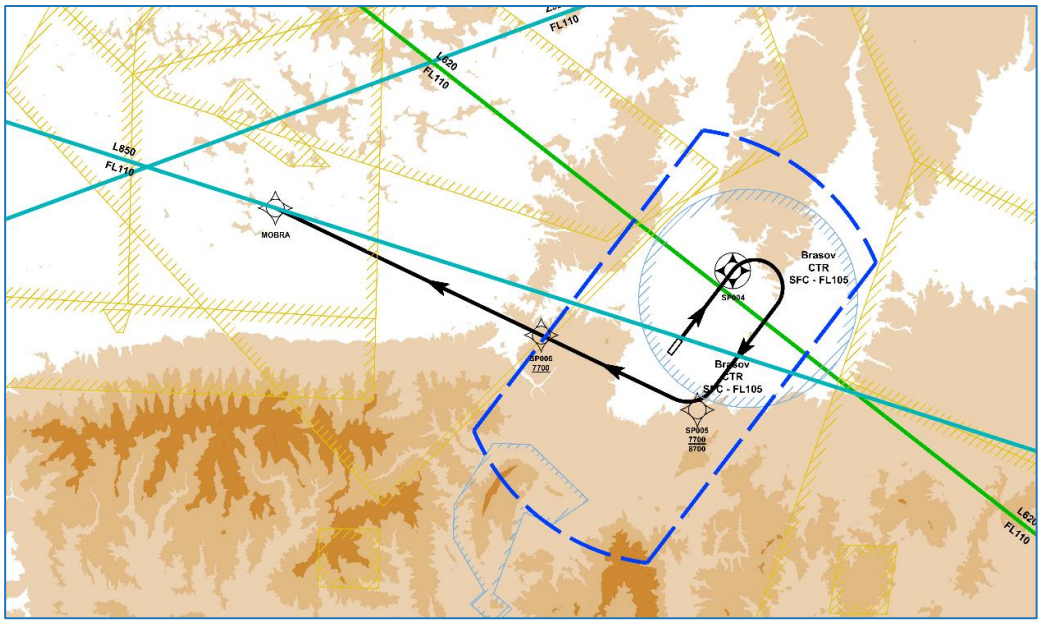

Figure 3: SID RWY 04 Westbound - L850

4.4. Eastbound Departures (L620)

4.4.1. As depicted in Figure 4, aircraft departing RWY 04 to join ATS route L620, climb out on runway heading, before performing a right turn at a flyover waypoint (SP004), then on a Direct to Fix (DF) leg to a fly-by waypoint (SP005), with an altitude restriction window of 7700ft to 8700ft (due to the arrivals onto RWY 04). The route then turns left at waypoint SP005 to a fly-by waypoint (SP007) at or above FL110, to remain separated from aircraft on the STAR. The SID ends at en-route waypoint LAPKA.

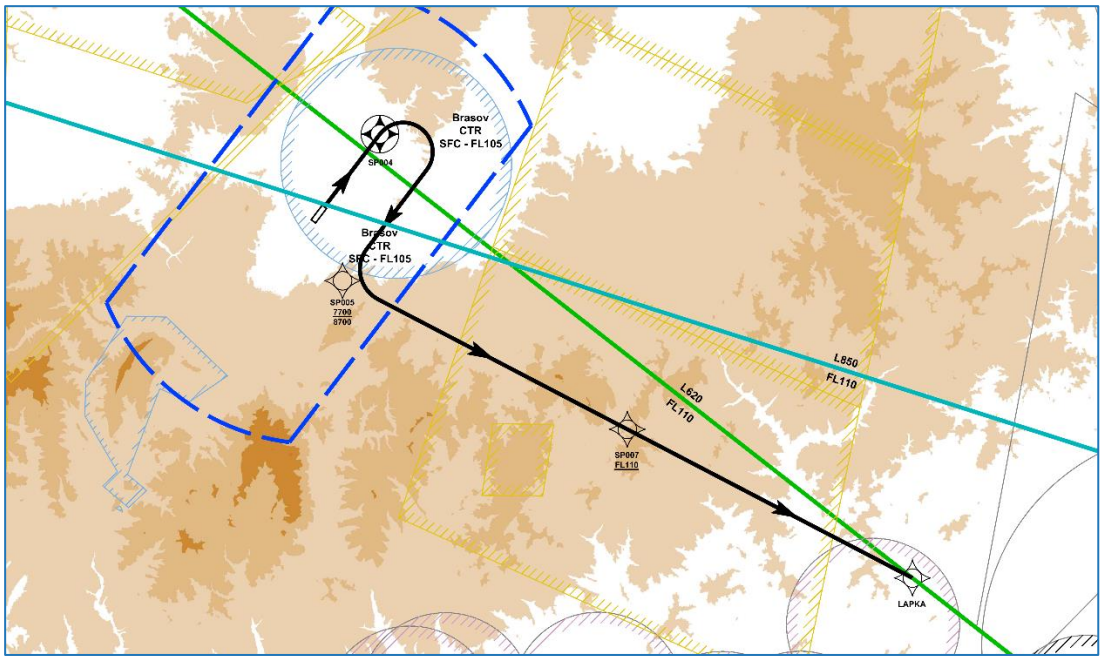

Figure 4: SID RWY 04 Eastbound - L620

4.5. Northbound Departures (Z650)

4.5.1. As depicted in Figure 5 aircraft departing RWY 04 to join ATS route Z650, climb out on runway heading, before a slight right turn to a flyby waypoint before turning left to a flyby waypoint connected at ATS route Z650. The purpose of the slight right turn is to avoid military airspace while aligning to the gap created between TRAs 72A, 73A, 14 and 28.

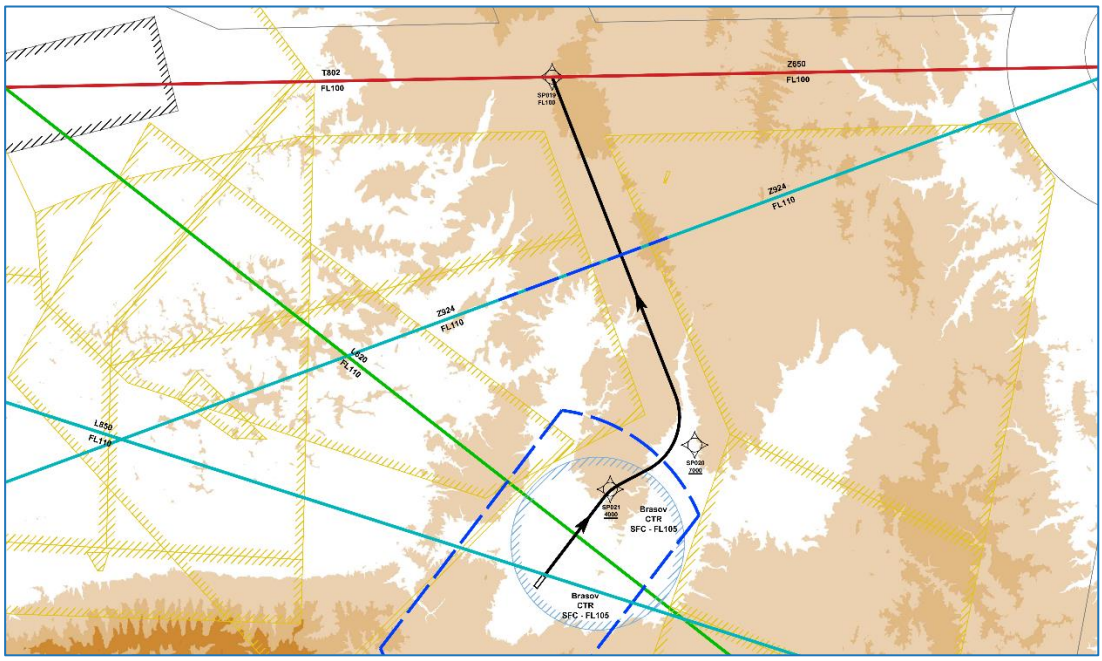

Figure 5: Northbound Departures RWY 04

4.6. Standard Terminal Arrival Routes

4.6.1. Design consideration for the STARs was to keep airspace usage to a minimum. Terrain to the south of the airport prohibits an IAP from the east with an approach gradient below 6.5%.

4.6.2. The resulting STARs conflict with the departure procedures, preventing the implementation of continues descent operations (CDO) in the procedural environment.

4.7. Arrivals from the East – L850

4.7.1. The Hold is positioned along the ATS route, at approximately 20NM from the BIA Aerodrome Reference Point (ARP). The hold orientation aids approach efficiency as aircraft are not required to enter the hold before commencing the arrival. The arrival is initiated from FL100 to ensure separation from the westbound departures.

4.7.2. As depicted in Figure 6, on leaving the hold, the aircraft descends to fly-by waypoint (SP015) at or above 9700ft, to ensure separation from the departing traffic, the aircraft then turns left onto the downwind, descending to 6700ft by fly-by waypoint (SP012) to ensure the aircraft is separated from the SID departing to the west.

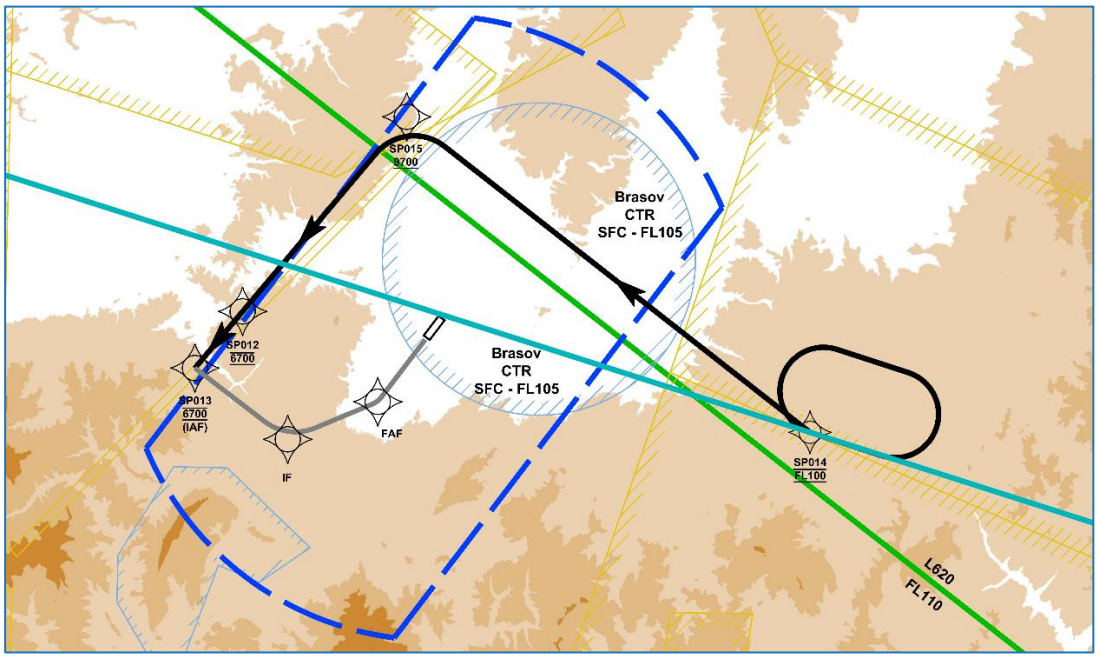

Figure 6: STAR RWY 04 - L850

4.8. Arrivals from the West – L620

4.8.1. The hold is situated along the ATS route approximate 15NM from the ARP and is orientated so aircraft are not required to enter the hold before commencing the arrival. The arrival is initiated from FL130.

4.8.2. As depicted in Figure 7, on leaving the En-Route or hold, the aircraft descends to fly-by waypoint (SP015) at or above 9700ft to ensure separation from the departing traffic. The aircraft then turns right onto the downwind, descending to 6700ft by fly-by waypoint (SP012), to ensure the aircraft is separated from the SID departing to the West.

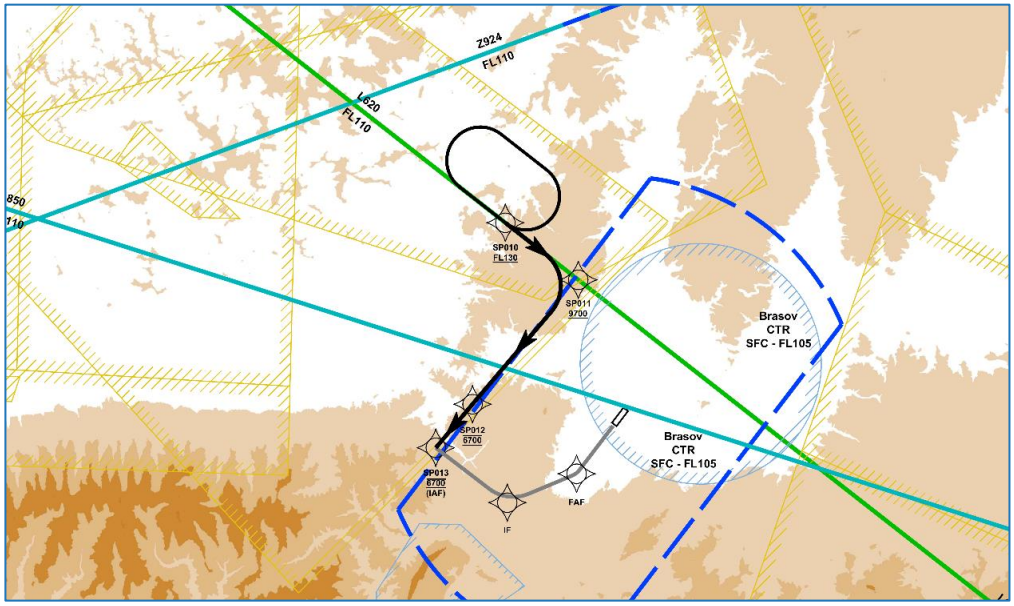

Figure 7: STAR RWY 04 – L620

4.9. Arrivals from the South – M747

4.9.1. The STAR commences at a Hold established on ATS Route M747 orientated to release aircraft in the direction of BIA. The approximate distance from BIA is 27NM.

4.9.2. Due to the orientation to BIA, this STAR is effectively a straight-in arrival for the IAP.

4.9.3. Although this STAR is restricted by the one-way ATS Route M747, it does not impact any military training areas and is the only STAR that can be used at all times.

4.9.4. Aircraft inbound from the South-West or West of BIA will not be able to flight plan effectively to access the Airport, as such this is only limited to aircraft flight planned via M747 from the South-East and East of BIA.

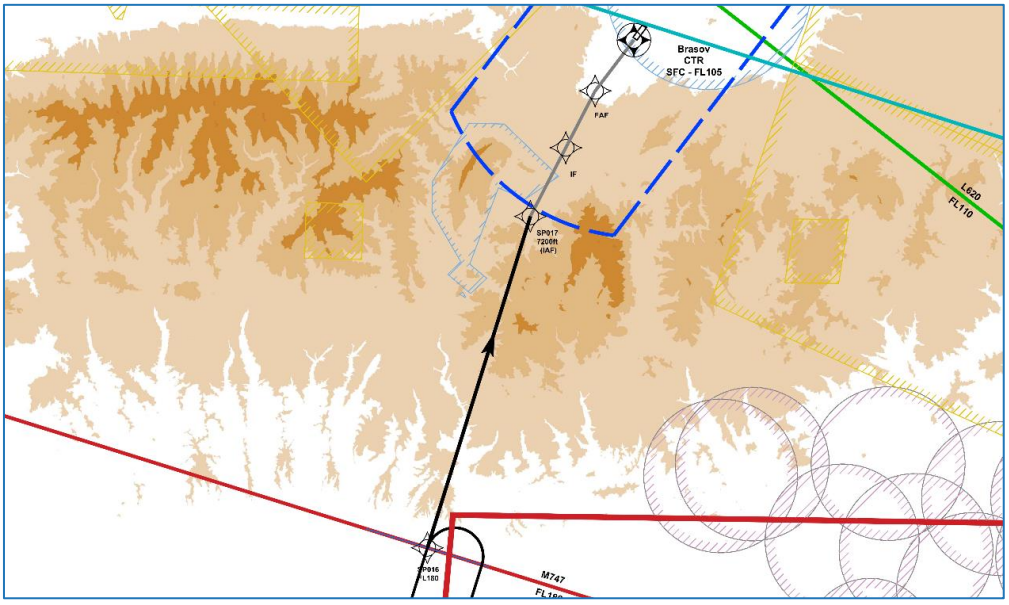

Figure 8: STAR RWY 04 – M747

5. Runway 22

5.1. Overview

5.1.1. An overview of the proposed SIDs and STARs for RWY 22 operation is depicted in Figure 9, showing the nominal tacks and entry exit points along the en-route, for the SIDs and STARs. As BIA is intended to operate with procedural control, all SIDs and STARs have been constructed to RNP Criteria.

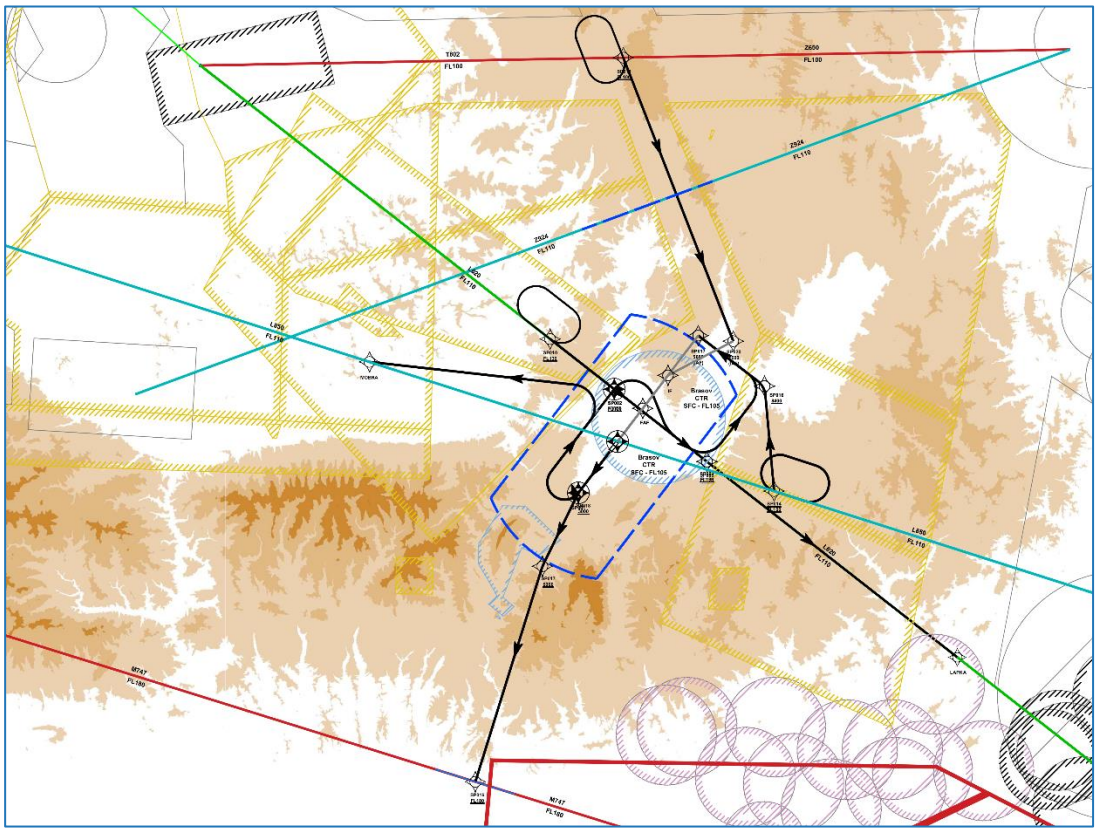

Figure 9: RWY 22 Operations SIDs / STARs

5.1.2. The track miles for the configuration of the SIDs and STARs are shown in

Procedure	Track Mileage
SID RWY 22 L620	66NM
SID RWY 22 L850	56NM
SID RWY 22 M747	43NM
STAR RWY 22 L620	43NM
STAR RWY 22 L850	23NM
STAR RWY 22 Z650	36NM

5.1.3. Table 2 and consider the distance to or from the ATS route network.

Procedure	Track Mileage
SID RWY 22 L620	66NM
SID RWY 22 L850	56NM
SID RWY 22 M747	43NM
STAR RWY 22 L620	43NM
STAR RWY 22 L850	23NM
STAR RWY 22 Z650	36NM

Table 2: Runway 22 Procedures Track Miles

5.2. Standard Instrument Departures

5.2.1. The SIDs were designed to reduce the required volume of airspace. By keeping the nominal track within the CTR the majority of climb can be achieved in the proximity of the airport. However, in the procedural environment continuous climb operations cannot be achieved, due to the separation required from the overlapping STARs. To keep the arc turn radius to a minimum, the procedures have been limited to 210kts, with a minimum bank angle of 25°. Due to the high terrain to the south, a minimum PDG of 7% was used for construction.

5.3. Westbound Departures (L850)

5.3.1. As depicted in Figure 10, aircraft departing RWY 22 to join ATS route L850, climb out on runway heading, before performing a right turn at a flyover waypoint (SP001), then on a direct to dix (DF) leg to a fly-by waypoint (SP002) at or above FL100, due to the arrivals onto RWY 22 indicated in Figure 9, the SID ends linking to the lower en-route structure at waypoint MOBRA.

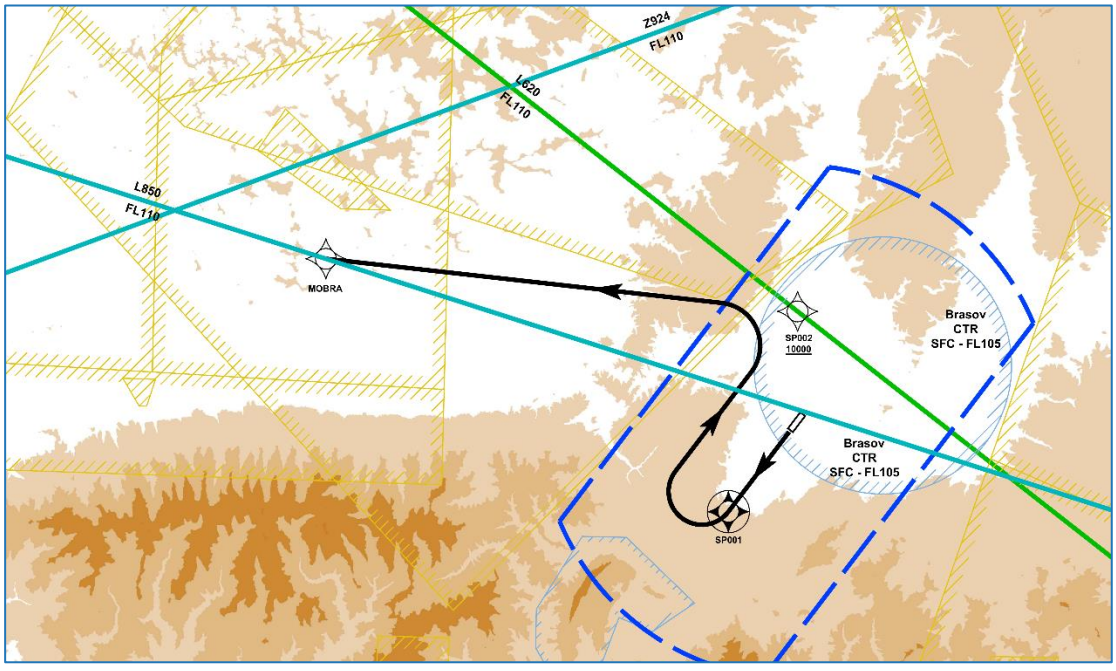

Figure 10: SID RWY 22 Westbound - L850

5.4. Eastbound Departures (L620)

5.4.1. As depicted in Figure 11, aircraft departing RWY 22 to join ATS route L620, climb out on runway heading, before performing a right turn at a flyover waypoint (SP001), then on a DF leg to a fly-by waypoint (SP002) at FL120. Due to the arrivals onto RWY 22 indicated in Figure 9, fly-by waypoint SP003 ensures aircraft remain at FL120 to remain separated from aircraft on the STAR. The SID ends at en-route waypoint LAPKA.

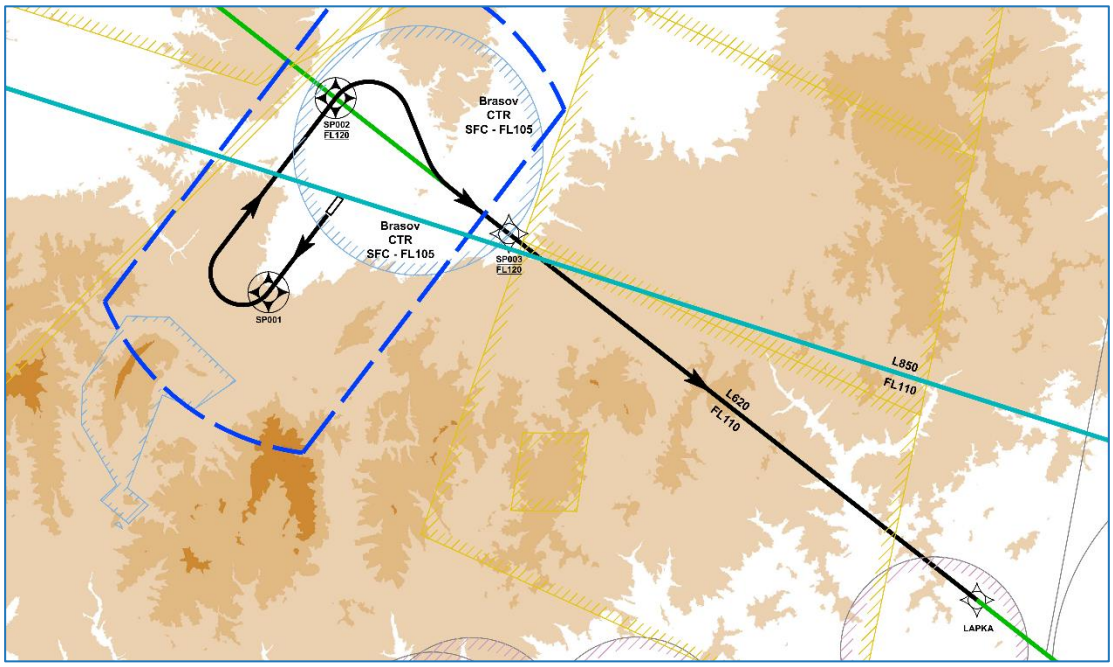

Figure 11: SID RWY 22 Eastbound - L620

5.5. Standard Terminal Arrival Routes

5.5.1. Design consideration for the STARs was to keep airspace usage to a minimum, whilst supporting sufficient track miles to prevent excessive descent gradients.

5.6. Arrivals from the East – L850

5.6.1. The Hold is situated along the ATS route at approximate 20NM from the BIA ARP. Aircraft are not required to enter the hold before commencing the arrival procedure. The arrival procedure is initiated from FL100 to separate from the westbound departures.

5.6.2. As depicted in Figure 12, on leaving the ATS route, the aircraft descends to fly-by waypoint (SP016) at or above 8400ft, the aircraft then turns left, descending to the IAF at 5600ft to initiate the IAP.

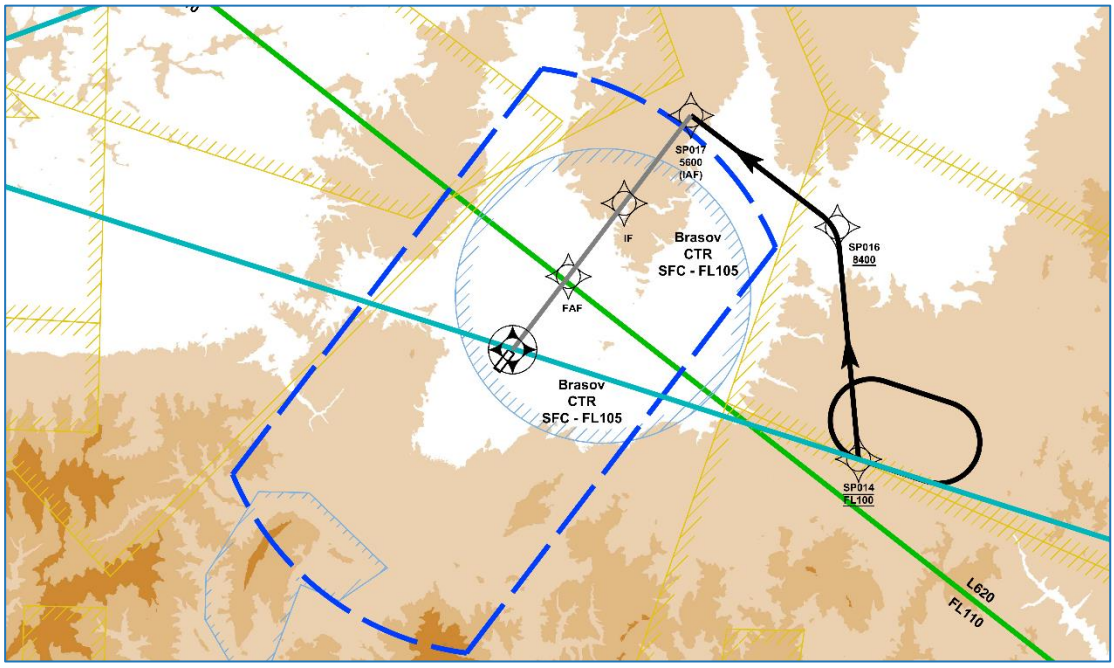

Figure 12: STAR RWY 22 - L850

5.7. Arrivals from the West – L620

5.7.1. The hold is situated along the ATS route at approximately 15NM from BIA ARP. Aircraft are not required to enter the hold before commencing the arrival. The arrival is initiated from FL130.

5.7.2. As depicted in Figure 13, on leaving the ATS route, the aircraft descends to fly-by waypoint (SP003) at or above FL130 to ensure separation from the departing traffic. The aircraft then turns left onto the downwind, descending to 8400ft, then a right turn to the IAF (SP017) at 5600ft.

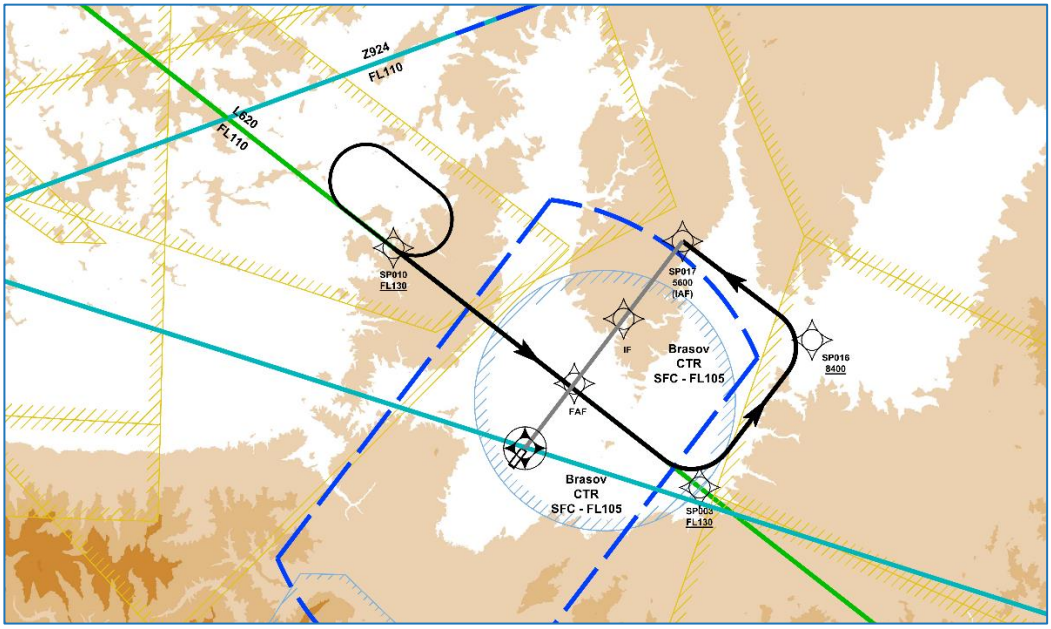

Figure 13: STAR RWY 22 – L620

5.8. Arrivals from the North – Z650

5.8.1. Figure 14 indicates a proposed procedure linking arrivals from the north via Z650 to the Airport. The STAR leaves the En-Route and follows a channel between the existing TRAs. However due to the large track change required when arriving from the east, the turn protection results in a larger portion of airspace, to contain the turn.

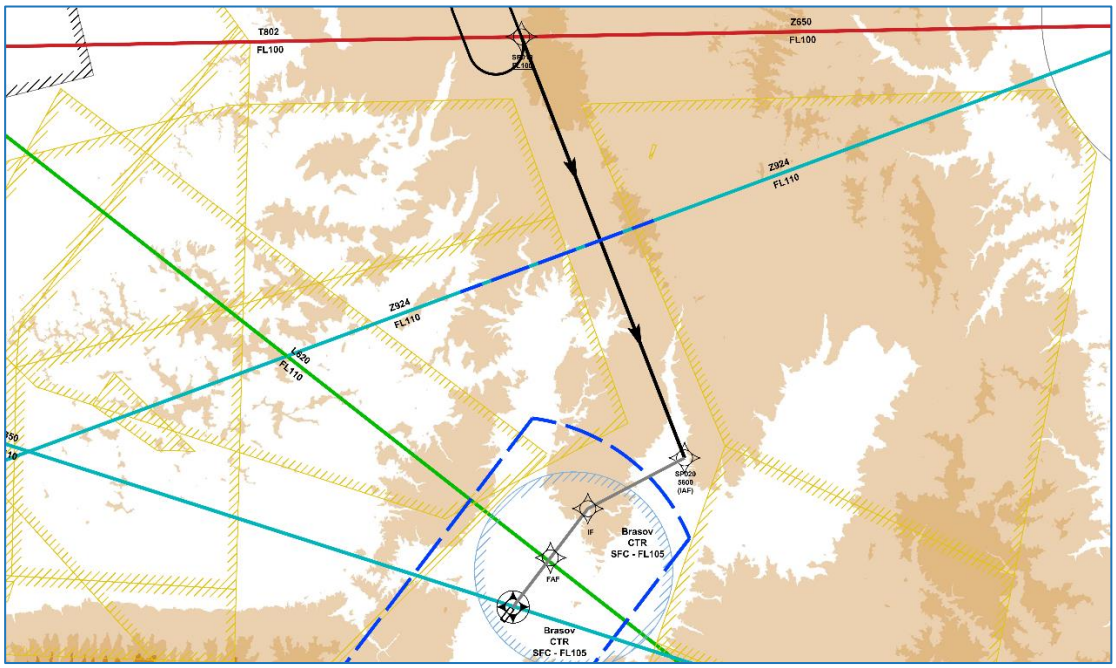

Figure 14: Arrivals from the North - Z650

6. ILS Runway 22

6.1. Design Constraints

6.1.1. For aircraft with low climb performance, terrain to the south of the airport will result in a significant increase in obstacle clearance altitude/height (OCA/H), as the airport is predicted to receive around 200 days of fog per annum. Aircraft unable to reach their decision altitude/height (DA/H) and are unable to hold for extended periods until the weather improves would be required to divert.

6.1.2. To accommodate for diversion in the procedural environment, the missed approach for the ILS RWY 22, will ideally have to return to a holding point established on the existing en-route structure.

6.1.3. As the positions for the conventional navigation aids have not yet been confirmed, the STAR is linked to the ILS procedure with an RNP transition. If no suitable conventional missed approach route cannot be established to return to the en-route, the missed approach procedure will be required to convert back to RNP. Doing so in the initial phase of the missed approach will result in increased pilot workload.

6.2. Design Concept

6.2.1. The terrain environment results in the aircraft intercepting the ILS no less than 4400ft, the nominal final approach point (FAP) will be located approximately 8.5NM from the Threshold (THR) of RWY 22.

6.2.2. The missed approach climbs out on the extended runway centreline, to a fix located at 7.5NM from the THR RWY 22, turning right to return to a hold on the en-route. The Missed Approach has been designed in attempt to reduce the OCA/H penalty for aircraft unable to achieve a missed approach climb gradient greater than 2.5%.

6.2.3. To calculate an indicative OCA/H with no provided ETOD survey data, a fixed 10m vertical buffer was applied to the terrain in a 3NM radius around the ARP, outside of this region a 30m buffer was added to the terrain to account for obstacles.

6.2.4. The ILS Approach criteria for CAT D[4] aircraft was used to get the worst-case protection areas, OCA/H values could potentially be lower for slower aircraft categories.

6.2.5. Table 3, indicates the lowest OCA/H calculated for the ILS CAT I and CAT II criteria, along with the required Missed Approach Climb Gradient (MACG), as it is a requirement to publish the OCA/H values for a 2.5% MACG on the chart, the associated OCA/H is also calculated.

[4] Aircraft type as per the Operational Requirements document.

	CAT I ILS CAT D	CAT II ILS CAT D
OCA (OCH) 2.5%	2883 (1163)	2806 (1086)
OCA (OCH) 4.5%	1930 (210)	1854 (134)

Table 3: Calculated OCA/H for ILS CAT I/II

6.2.6. As can be seen, the OCA/H values for a 2.5% MACG are very high, the result being that aircraft would probably not be able to land in adverse weather conditions. An increase in the MACG to 4.5% results in a lower OCA/H but still not down to heights normally associated with CAT II minima.

6.2.7. The values indicated in Table 3 will change with accurate airfield and surrounding area obstacle survey data. Terrain to the south of the airport results in OCA/H values unsuited to adverse weather conditions for lower MACG.

6.2.8. Figure 15 provides an overview of the RWY 22 RNP STARs connecting to the ILS with the dotted arrow line indicating the MAP.

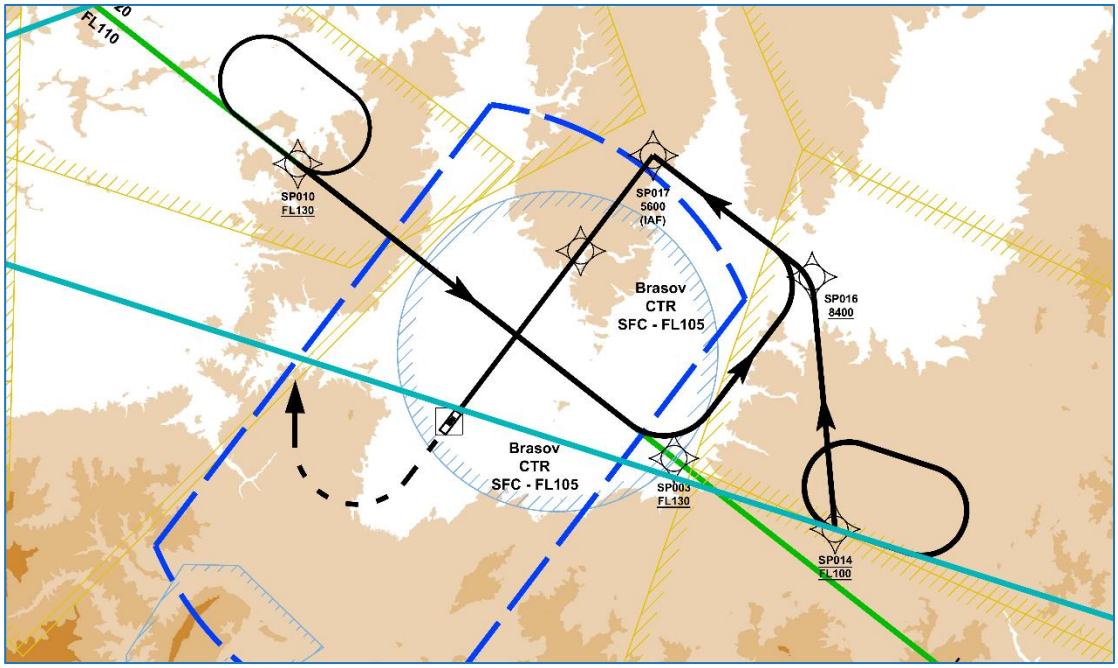

Figure 15: ILS RWY 22

7. Conclusions and Recommendations

7.1. This concept document evidences the feasibility of procedures that will allow continuous operations at BIA without impact military operations. It is acknowledged that some airspace concessions will be required but have been limited to a minimum.

7.2. Arrival and departures routes have been provided in four directions North, East, South and West from the Airport. These routes will maximise access to the route network.

7.3. It is accepted that when military trainings areas are active, route access to BIA will be limited but not overly restricted.

7.4. Flexible Use of Airspace (FUA), used effectively, will ensure all users gain access to the airspace required whilst ensuring continued safe operations.

7.5. The feasibility of the concepts, designed to PANS-OPS criteria, will allow for final design to consolidate procedure arrangements for operational implementation.

7.6. It is recommended that during the final design phase, consultation with all relevant stakeholders is considered and where applicable FUA, Letters of Agreement (LOA) or Memorandums of Understanding (MOU) are arranged.

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