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Standard Instrument Departure Design for Runway 30 at Airnav Indonesia Curug Sub-Branch

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Abstract:

This study aims to design a Standard Instrument Departure (SID) procedure for Runway 30 at Budiarto Airport, located in Curug, Tangerang Regency, Banten Province. The airport features unique characteristics, including intersecting runways. In addition to serving as a training airport for the Indonesian Aviation Polytechnic Curug (PPIC), Budiarto Airport is frequently used for aircraft maintenance by PT. ANI. Currently, Budiarto Airport is extending Runway 30 from its original length of 1823 x 45 meters to 2150 x 45 meters. This extension aims to accommodate a wider variety of aircraft types for operators, particularly for maintenance services, and to attract business interest for establishing domestic flight routes. One of the navigational facilities at the airport is the VOR BTO, which allows for safe and efficient aircraft guidance. Implementing a SID procedure using VOR can significantly enhance safety and efficiency for aircraft operations.

The research methodology employed is a Level One Research and Development (R&D) approach, involving data collection through literature reviews, documentation, and interviews with experts, including ATC personnel and flight procedure designers. The research process includes several stages: identifying potential issues and problems, gathering information, designing the product, validating it with experts, and developing an SID plan that meets safety and efficiency standards according to ICAO Doc. 8168.

The research findings, based on interviews with several experts, indicate that the proposed SID design can improve safety and efficiency at Budiarto Airport. It will also assist ATC in managing aircraft maneuvers while reducing communication workload. The design has been validated by experts and is deemed ready for implementation. However, it is noted that this design represents an initial study that could lead to further research and new insights, especially regarding procedures when the SID is fully implemented. Further research is needed, particularly for VFR training aircraft from the local flight schools at Budiarto.

Keyword: *Standard Instrument Departure*, VHF Omnidirectional Range - Bearing To, Research and Development Level One.

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Introduction

Budiarto Airport, established as Tjoeroeg Airport in 1952, is located in Curug, Tangerang Regency, Banten Province. It serves multiple roles, including aviation and aircraft maintenance under PT. Aero Nusantara Indonesia and as a center for aviation research and education. The airport features intersecting runways to manage variable wind conditions, with Runway 12-30 at 1832 meters and Runway 22-04 at 1602 meters.

Primarily, Budiarto Airport functions as the main training facility for the Indonesian Aviation Polytechnic in Curug (PPIC), equipped with navigational aids like the VOR BTO system. This system enhances flight safety by assisting aircraft in determining their direction, distance, speed, and altitude. A key procedure used with these Nav Aids is the Standard Instrument Departure (SID), which standardizes departing aircraft procedures to improve safety and efficiency.

Figure 1. Airspace Airport Soekarno-Hatta (Author 2024)

Despite a low volume of IFR traffic, Budiarto Airport faces potential collision risks with aircraft from the nearby Soekarno-Hatta Airport. Departing flights from Budiarto currently follow an informal left turn to a heading of 270 degrees to avoid conflicts. Senior ATC officials have noted that the lack of formal procedures between the two airports can lead to inconsistencies and increased accident risks. ICAO Annex 11 (2018) emphasizes the importance of air traffic controllers providing standardized air traffic services, making the design and implementation of a SID procedure essential.

The focus on designing a SID for Runway 30 is due to its longer length of 1832 meters, suitable for aircraft like the Boeing 737 series. Currently being extended to 2150 meters, Runway 30 will meet the airport's growing capacity needs. Although primarily a training facility, Budiarto Airport also holds potential for domestic flight operations, as outlined by Indonesian Minister of Transportation's Regulation KM 33 (2024). Developing a SID will enhance flight procedures for commercial aircraft and benefit training activities by improving the skills and readiness of aviation students.

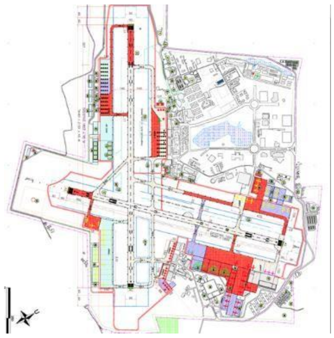

Figure 2. New Grand Design Budiarto,Curug. Attachment to the Budiarto Airport Master Plan (2024).

The SID design will enhance flight procedures for commercial aircraft and significantly benefit training activities. Structured and safe training procedures using existing flight instruments will improve the skills and readiness of aviation students, preparing them to handle various real-world flight conditions.

Given these opportunities and ongoing developments, Budiarto Airport must be equipped with comprehensive procedures, including the SID, to ensure safety, efficiency, and future growth in aviation services. This advancement will solidify Budiarto Airport's role as a pivotal training and service center in Indonesian aviation.

Method

The primary objective of this research is to outline the steps for designing the Standard Instrument Departure (SID) procedure for Runway 30 at AirNav Indonesia, Curug Branch. The study aims to provide substantial insights and recommendations to the Directorate General of Civil Aviation and AirNav Indonesia, Curug Branch, to implement a standardized SID procedure that ensures safe separation of departing aircraft.

1. Population: All Air Traffic Control (ATC) personnel at Perum LPPNPI Curug Sub-Branch Office and Jakarta Air Traffic Service Centre (JATSC).
2. Sample: One ATC personnel from Perum LPPNPI Curug Sub-Branch and several ATC personnel from JATSC.

This study employs the Research and Development (R&D) method, focusing on developing a SID design for Runway 30 at Perum LPPNPI Curug Branch. Conducted at level one of the R&D process, the research involves data exploration and SID design without extensive field testing or production.

a. Research Steps

Identify Potential and Problems: Conduct documentation studies, interviews, and literature reviews to identify relevant issues and gather information.

Literature Review and Research: Collect and analyze relevant data to inform the design of the SID.

Product Design: Develop the SID for Runway 30 based on ICAO Document 8168/611 standards.

Product Validation: Validate the SID design with ATC practitioners, educational experts, and PANS-OPS designers.

Design Testing: Internally validate the design in adherence to level one R&D standards, without external production or field testing.

b. Data Collection Techniques

Literature Study: Collect theoretical foundations and relevant information from documents, regulations, and other written sources.

Documentation: Gather supporting data from Standard Operating Procedures (SOP) and Aeronautical Information Publications (AIP).

Interviews: Conduct unstructured interviews to gain deeper insights from respondents.

Results and discussions

This research focuses on designing the SID for Runway 30 at Budiarto Airport, located in Curug, Tangerang. Budiarto Airport is pivotal in aviation education and aircraft maintenance services, making it a key hub in the region's aviation sector. Currently, Runway 30 measures 1823 x 45 meters, but an extension project is underway to expand it to 2150 x 45 meters. This extension aims to accommodate larger aircraft, such as the Boeing 737-800, attract additional operators for aircraft maintenance, and enable the airport to handle domestic flights.

The runway extension necessitates the development of a SID to meet increasing operational demands and ensure safety and efficiency at Budiarto Airport. The SID design is intended to address complex operational needs while maintaining high standards of flight safety and efficiency. Given that Budiarto Airport shares airspace with Soekarno-Hatta Airport, a well-structured SID is crucial for ensuring safe coordination between aircraft operating at both airports.

The research includes an analysis of flight data and safety factors related to SID design. The anticipated outcome is to significantly enhance service quality and operational efficiency at Budiarto Airport. Designing the SID requires comprehensive supporting data about the airport to ensure a well-informed and effective design process.

1. Urgency of Implementing Standard Instrument Departure (SID)

   According to (Menteri Perhubungan Republik Indonesia, PM 65 Air (2017)), establishing Standard Instrument Departure (SID) procedures is crucial for ensuring the safety, orderliness, and efficiency of air traffic movements. These procedures are essential for clarifying routes and protocols within air traffic control clearances. Implementing an SID at Budiarto Airport is expected to enhance flight safety, orderliness, and operational efficiency, especially with the extended runway and increased airport capacity. Additionally, given Budiarto Airport's proximity to Soekarno-Hatta Airport, a well-structured SID is necessary to improve coordination and reduce potential air traffic conflicts.
2. Function of Standard Instrument Departure

   The primary function of SID, as outlined in ICAO Document Annex 4 (Aeronautical Chart – Instrument (SID)), 2009). is to provide flight crews with standardized departure routes from takeoff to the en-route phase. This ensures that aircraft can transition safely and efficiently from the airport to established air routes. The SID provides clear guidance on the paths to follow immediately after takeoff, which is critical for maintaining safety and being monitored by ATC units. Designing an effective SID for Budiarto Airport will facilitate safe transitions from the airport to en-route phases.
3. Implementation of Standard Instrument Departure for Transfer of Control Between Units

   ICAO Doc. 4444 ATM/501 (2016) underscores the importance of standardized procedures for transferring control between ATC units and issuing standard clearances for departing aircraft. The transfer of control involves shifting aircraft management responsibilities from one ATC unit to another, which is essential for smooth and safe flight operations. Without standardized procedures, there is a higher risk of errors and miscommunication, which could lead to incidents or accidents. Implementing an SID helps to structure departure routes, making the transfer of control between ATC units more manageable and safer, particularly in the airspace near Budiarto and Soekarno-Hatta Airports where air traffic density is high.

4. Organization and Operations of Budiarto Airport Unit
   (Menteri Perhubungan Republik Indonesia, PM 41 (2014)) outlines the roles and responsibilities of the Budiarto Airport Unit, including providing airport services, supporting research and development, aviation education and training, and ensuring aviation safety and security. As a research and development center, Budiarto Airport must offer facilities that support aviation research, including laboratories, simulation rooms, and testing facilities. The airport's commitment to aviation safety and security further emphasizes the need for SID implementation, as standardized procedures are vital for safe and efficient flight operations.
5. Designing Flight Procedures
   (Direktorat Jenderal Perhubungan Udara, KP 209 (2019)) flight procedures must adhere to ICAO Document 8168 standards. This document provides comprehensive guidelines for developing visual and instrument flight procedures, ensuring they meet international standards. The extension of Budiarto's runway and increased capacity necessitate the development of new procedures to accommodate higher traffic volumes and a broader range of aircraft. These procedures must address safety and operational efficiency while supporting effective control transfer with relevant ATC units. Compliance with ICAO Document 8168 and KP 209 (2019) ensures that the designed procedures are safe, efficient, and internationally compliant.
6. Potential for Providing Domestic Aviation Services
   As outlined in (Menteri Perhubungan Republik Indonesia, KM 33 (2024)), Budiarto Airport is projected to handle domestic flights, necessitating the implementation of appropriate aviation facilities and standard procedures like SID. Preparing for this potential involves designing procedures that adhere to international standards, enhancing the airport's capability to efficiently and safely handle domestic aviation services.

These highlights underscore the theoretical frameworks and regulatory guidelines that support the development and implementation of Standard Instrument Departure (SID) procedures at Budiarto Airport. Adhering to these established standards and principles will enable the airport to improve its operational safety, efficiency, and preparedness for handling increased traffic and domestic flight services (ICAO Council, 2018)

The following data pertains to the work region as outlined in the Standard Operating Procedure (SOP) from AirNav Indonesia, Curug Branch (2022):

1. Aerodrome Data
   a. Office/City Name:
      Perum LPPNPI Cabang Pembantu Curug
   b. ICAO Location Indicator:
      WIRR
   c. Aerodrome Coordinates:

6°17’36”S 106°34’5”E

d. Elevation:
140 ft

e. Magnetic Variation (MAG VAR) / Annual Change:
1°E (2020) / 0.03° Decreasing

f. Address:
Jl. Raya Curug Tromol Pos 08, Tangerang – Banten

g. Operating Hours:
Sunday to Thursday: 23:00 – 10:30
Friday: 23:30 – 05:30

h. Typer of Traffic Permit:
IFR / VFR

i. Budiarto Airport Runway Facilities:

Table 1. Runway facility Budiarto, Curug

RWY Designator	12	30	04	22
Azimuth	119.57°	299.57°	043.70°	223.70°
RWY Dimention	1 823 x 45	1 823 x 45	1 600 x 45	1 600 x 45
Strength (PCN)	37/F/C/X/T Asphalt	37/F/C/X/T Asphalt	37/F/C/X/T Asphalt	37/F/C/X/T Asphalt
THR Coordiantes	THR 06°17’16.74”S 106°33’38.91”E	THR 06°17’46.03”S 106°34’30.51”E	THR 06°17’42.84”S 106°34’04.11”E	THR 06°17’05.19”S 106°34’40.07”E
THR Elevation	134 ft	140 ft	136 ft	125 ft
Slope of RWY	0.089 % down to RWY 12	0.089 % down to RWY 12	0.22 % down to RWY 22	0.22 % down to RWY 22
SWY Dimention	NIL	60 x 45	NIL	NIL
CWY Dimention	150 x 150	210 x 150	60 x 150	210 x 150
STRIP Dimention	1 943 x 300	1 943 x 300	1 720 x 150	1 720 x 150

Source: AIP Indonesia (2021)

Table 2. New Runway Plan After Extension

RWY Designator	12	30
Azimuth	119.57°	299.57°
RWY Dimention	2 150 x 45	2 150 x 45
Strength (PCN)	37/F/C/X/T Asphalt	37/F/C/X/T Asphalt
THR Coordiantes	THR 6°17'11.66"S 106°33'29.96"E	THR 06°17’46.03”S 106°34’30.51”E
THR Elevation	134 ft	140 ft

Source: UPBU Budiarto KP 835 Master Plan (2014)

2. Budiarto Airport Declared Distance

Tabel 3. Declared distance

RWY Designator	TORA	TODA	LDA	ASDA
12	1 823	1 973	1 823	1 823
30	1 823	2 033	1 823	1 823
04	1 600	1 600	1 600	1 600
22	1 600	1 810	1 600	1 600

Source: AIP Indonesia (2021)

3. Budiarto Airport Taxiway Facility

Table 4. Taxiway Facility

TAXIWAY	LENGTH (m²)	WIDTH (m²)	STRENGTH
Alpha	210	18	37/F/C/X/T Asphalt
Bravo	400	18	37/F/C/X/T Asphalt
Charlie	150	23	37/F/C/X/T Asphalt
Delta	1132	18	37/F/C/X/T Asphalt
Echo	150	20	5670 kg Grass
Foxtrot	150	20	5670 kg Grass
Golf	580	22	37/F/C/X/T Asphalt
Hotel	325	20	37/F/C/X/T Asphalt
India	150	23	37/F/C/X/T Asphalt
Lima	150	23	37/F/C/X/T Asphalt

Source: AIP Indonesia (2021)

4. Budiarto Airport Apron Facility

Table 5. Fasilitas apron

APRON	DIMENSION	STRENGTH
Apron A	438 X 58 = 25 404 m²	37/F/C/X/T Asphalt
Apron B	106 X 96 = 10 176 m²	37/F/C/X/T Asphalt
Apron C	200 X 100 = 20 000 m²	37/F/C/X/T Asphalt
Apron D1	170 x 60 = 10 200 m²	37/F/C/X/T Asphalt
Apron D2	128.5 X 54.5 = 7003.25 m²	37/F/C/X/T Asphalt

Source: AIP Indonesia (2021)

5. ATS Airspace

Table 6. ATS airspace

Designation and lateral limits	Curug CTR : 060828S 1060230E 055546S 1061233E 060012S 1062100E 061627S 1062100E 061627S 1062409E 061325S 1063707E 061902S 1064123E thence anticlockwise along the circle 12 NM radius centred 061558S 1065303E to 062141S 1064226E 063000S 1062949E 063000S 1060230E 060828S 1060230E
Vertical limits	GND / Water up to 3 000 ft MSL
Airspace classification	C
ATS unit call sign	Budiarto Tower
Language(s)	English
Transition Altitude	11 000 ft/ FL 130
Hours of applicability	SUN – THU : 2300 – 1030 FRI : 2330 - 0530
Remarks	- Out of OPR hours and holidays O/R - Aerodrome control service is provided within vicinity of aerodrome by Budiarto TWR

Source: AIP Indonesia 2021

Designing the Standard Instrument Departure (SID) for Budiarto Airport in Curug presents challenges due to its proximity to the Soekarno-Hatta airspace and the designated training areas for student pilots at Budiarto. The southern training area, in particular, significantly impacts the SID design, necessitating careful separation between instrument flight rules (IFR) and visual flight rules (VFR) aircraft as managed by air traffic control (ATC).

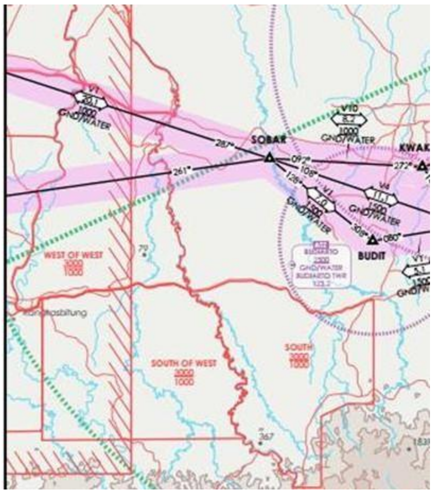

Figure 3. South and South of West Training Area Restrictions. Kegiatan Pelatihan Terbang Budiarto (2023)

The Standard Operating Procedures (SOP) for Flight Training Activities at Budiarto Airport, as outlined by (Airnav Indonesia Cabang Pembantu Curug, 2023) define the training area's boundaries using ground references like railway tracks. Training flights are restricted to altitudes between 1,000 and 3,000 feet. Implementing the Standard Instrument Departure (SID) requires air traffic control (ATC) to ensure separation between instrument and training flights, which may involve instructing training aircraft to adhere to specific altitudes and headings.

The research methodology encompassed field observations, literature reviews, documentation analysis, and interviews with ATC personnel and the Head of Budiarto UPBU.

The findings revealed a gap in available procedures at Budiarto compared to other airports, despite an anticipated increase in demand and capacity due to the ongoing extension of runway 30. This extension aims to accommodate a broader range of aircraft and attract more aviation operators, potentially allowing Budiarto to handle domestic flights.

Given the anticipated increase in flight services, implementing supportive procedures like the SID is crucial. The SID design process followed ICAO guidelines and employed AutoCAD 2022 for design work and Global Mapper with SRTM terrain data to assess obstacle heights. The calculations for the SID design for runway 30 at Budiarto were meticulously conducted in accordance with these standards.

6. SID Design

For the SID design itself must follow the international standards that listed in Doc. 8168 (International Civil Aviation Organization. Council., 2020)

a. Determining the Turning Altitude Position (TNA)

Table 7. *Data position* (TNA) Author (2024)

PDG	*3,3%*	
Elev. Runway	*134 ft*	*40,8432 m*
Alt. Over Der	*16 ft*	*4,8768 m*
TNH	*400 ft*	*121,92 m*
TNA	*400 + 134 = 534 ft ≈ 550 ft*	*167,64 m*

$$XTNA = (\,550ft - thr\ elev. - DER)\ x\ \frac{0{,}3048}{PDG}$$

$$XTNA = (550ft - 134\ ft - 16ft)\ X\ \frac{0{,}3048}{3{,}3\%} = 3694{,}5454\ m\ (1{,}9948949\ nm)$$

b. Assessment Obstacle in Turn Initiation Area (TIA)

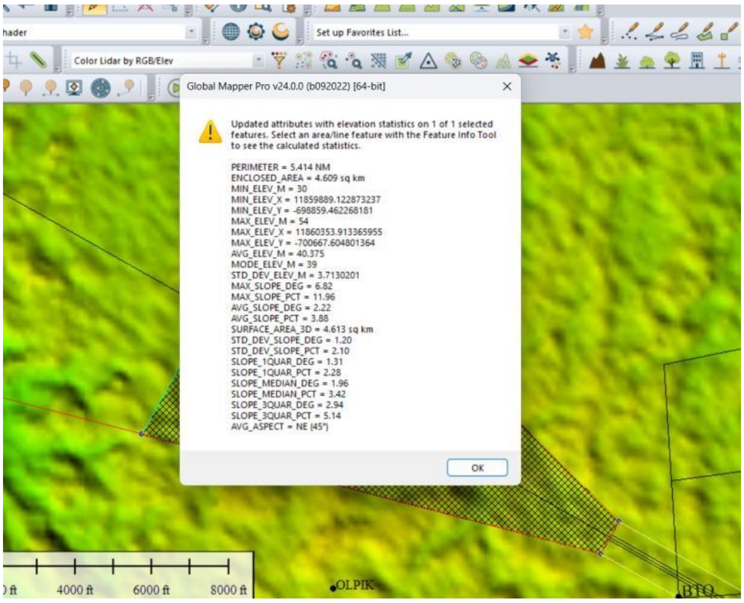

Figure 4. Obstacle Assessment TIA 1. Author (2024)

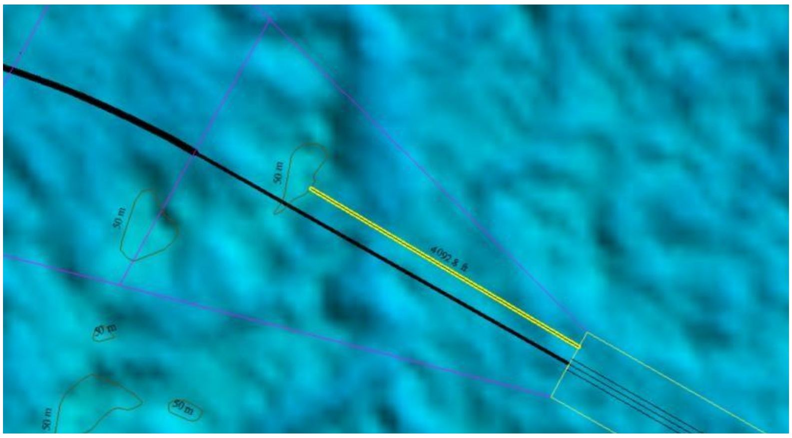

Figure 5. Obstacle Distance. Author (2024)

The assessment of obstacles in the area reveals that a TIA (Takeoff and Initial Approach) is required. The data includes the height and distance of obstacles from the Departure End of the Runway (DER) as follows:

Distance Obstacle (do) = 4 092 ft = 1 247,242m (1,453286 km)

Elevation Obstacle = 50 m

Runway elev = 134 f t = 40 m

All over DER = 5 m

Real Obstacle = 50 – (40 + 5) = 5 m

OIS = 1 247 x 2,5%

= 31,175 m

When the Obstacle Identification Surface (OIS) is greater than the actual obstacle height, it indicates that a Minimum Obstacle Clearance (MOC) is not required. Consequently, the Probability of Detection Gap (PDG) is set at 3.3%, ensuring that the aircraft is safely separated from existing obstacles. This standard ensures appropriate clearance for aircraft conducting instrument flights and quick separation from visually flying training aircraft.

To enhance vertical separation from surrounding traffic, the PDG is increased to 4.8%. This adjustment is also applicable when considering altitude over the VOR HLM, where the height is set to 9,500 feet to maintain proper vertical separation.

With the revised PDG, changes are reflected in the Takeoff and Initial Approach (TNA) procedures. Previously, a PDG of 3.3% was used; however, with the new PDG of 4.8%, adjustments in the TNA calculations are necessary to accommodate this change.New XTNA :

$XTNA = (550ft – thr\ elev. – DER)\ x$

XTNA = (550ft – 134 ft – 16ft) X = 2540 m (1,371 nm)

a. Assessment Obstacle in Turn Area

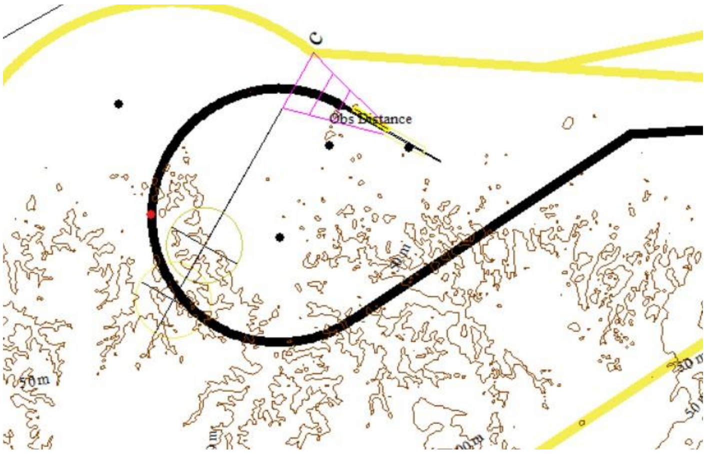

Figure 6. Assessment Obstacle in Turn Area. Author (2024)

In the obstacle data image above, the detected obstacle is assumed to be at an altitude of 50 meters. Referring to the previous calculations in the Takeoff and Initial Approach (TIA), if the obstacle height is indeed 50 meters, the aircraft is considered safe when using the standard Probability of Detection Gap (PDG) of 3.3%.

b. Protection Area

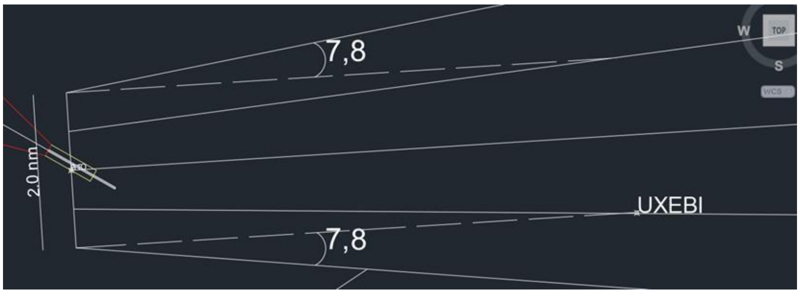

Figure 7. Protection Area. Author (2024)

To determine a protection area, it is essential to consider the navigation aids at an airport. At Budiarto Airport, the VOR BTO is used as a navigation aid. A straight line is then drawn parallel to the intended en-route direction, connecting the SID point to the designated en-route point. The protection area between the VOR BTO and the High-Level Marker (HLM) spans a width of 2 nautical miles, with the Splay widening by 7.8° until it intersects with the en-route area.

c. Turn Parameter

a. IAS (*Indicated Air Speed*)

IAS = (*Max. Final M A Speed*) + 10%

IAS = 240 kt + 10% = 264 kt

b. TAS (*True Air Speed*)

In the Conversion Table for IAS to TAS Calculations ICAO Doc. 8168, the determination of the k value is as follows :

Altitude (feet)	Conversion factor							
	ISA−30	ISA−20	ISA−10	ISA	ISA+10	ISA+15	ISA+20	ISA+30
0	0.9465	0.9647	0.9825	1.0000	1.0172	1.0257	1.0341	1.0508
1 000.0	0.9601	0.9787	0.9969	1.0148	1.0324	1.0411	1.0497	1.0667

Figure 8. Conversion Table for IAS to TAS. Doc 8168 Vol II

TAS = IAS x k

TAS = 264 x 1,0411 = 274,850 kts (141,3828 m/s)

d. Bank Angle *(a)* : 15 ^{0}

d. Rate of Turn (R)

$R = \frac{3431\ x\ TAN\ (a)}{\pi\ x\ TAS}$

$R = \frac{3431\ x\ TAN\ 15}{\pi\ x\ 274{,}850} = 1{,}1\ ^0$ /s

e. Radius of Turn *(r)*

$r = \frac{TAS}{20\ x\ \pi\ x\ R}$

$r = \frac{274{,}850}{20x\ 3{,}14\ x\ 1{,}1^0} = 4{,}10805$ nm (7.608,109 m)

f. Wind

30 kt (15,43 m/s)

g. *Flight technical tolerance* (c)

1) *Pilot Reaction* = 3s x (TAS + *Wind*)

Pilot Reaction = 3 x (141,3828 + 15,43) = 470,475 m (0,254036 nm)

2) *bank establishment time* = 3s x (TAS + wind)

bank establishment time = 3 x (141,395 + 15,43) = 470,475 m (0,254036 nm)

Flight technical tolerance (c) = 0,254036 + 0,254036 = 0,508072

h. Wind Effect

$E = (\frac{90}{R})\ x\ wind$

$E = (\frac{90}{1{,}065})\ x\ 15{,}43 = 1303{,}943\ m\ (0{,}70407\ nm)$

In planning *Standard Instrument Departure* the author uses the method *bounding circle* in ICAO doc. 8168 to provide protection for the outermost and innermost areas when the aircraft is flying *turning* in a designated area. Therefore, there are several additional calculations and steps that must be done. These steps are to calculate:

j. X = $\sqrt{r^2 + E^2} = \sqrt{4{,}1085^2 + 0{,}70407^2}$= 4,167 nm

*k.*Y = r + E = 4,1080 + 0,70407= 4,812 nm

l. Z = r + 2E = 4,1080 + 2x 0,70407 = 5,51 mn

6. *Average Path*

a.XTNA

XTNA = (550 – Thr Elev – DER) x $\frac{0,3048}{7\%}$

XTNA = (550 – 134 – 16) x $\frac{0,3048}{7\%}$ = 1741 m (0,940 nm)

g. TNH

TNH = TNA – Thr Elev

TNH = 550 – 134 = 416 ft (126,796 m)

(Distance in km (NM), height in m (ft), bank angle in degrees, speed in km/h (kt) IAS)

Distance from DER	1.9 (1)	3.7 (2)	5.6 (3)	7.4 (4)	9.3 (5)	11.1 (6)	13 (7)	14.8 (8)	16.7 (9)	18.5 (10)	20.4 (11)	22.2 (12)	24.1 (13)	25.9 (14)	27.8 (15)	29.6 (16)	31.5 (17)	33.3 (18)	35.2 (19)	37 (20
Height above rwy	130 (425)	259 (850)	389 (1 275)	518 (1 700)	648 (2 125)	777 (2 550)	907 (2 976)	1037 (3 401)	1167 (3 827)	1296 (4 252)	1476 (4 677)	1556 (5 103)	1685 (5 528)	1815 (5 953)	1945 (6 379)	2074 (6 804)	2204 (7 229)	2334 (7 655)	2463 (8 080)	2593 (8 50
Bank angle	15	15	20	20	20	20	20	25	25	25	25	25	25	25	25	25	25	25	25	25
Speed	356 (192)	370 (200)	387 (209)	404 (218)	424 (229)	441 (238)	452 (244)	459 (248)	467 (252)	472 (255)	478 (258)	483 (261)	487 (263)	491 (265)	493 (266)	494 (267)	498 (269)	502 (271)	504 (272)	511 (276

Note.— The speed shall not be higher than the maximum speed as indicated in Table I-4-1-1 and I-4-1-2.

Figure 9. Table *avarage flight path determination.* Doc. 8168 Vol II

c.Bank Angle = 15^0

d. IAS (Indicated Air Speed) 200 kt (102,89 m/s)

e.TAS (True Air Speed)

TAS = IAS x k

TAS = 200 x 1,0411 = 208,22 kt (107,11 m/s)

f. Rate of Turn (R)

R = $\frac{3431\ x\ TAN\ 15^0}{3{,}14 x 208{,}22} = 1.41^0/s$

g. *Radius of Turn (r)*

r = $\frac{TAS}{20\ x\ \pi\ x\ R}$

r = $\frac{208{,}22}{20 \text{ x } 3{,}14 \text{ x } 1{,}41}$ = 2,36 nm (4367 m)

The Highest Alt considered at next Way Point (WP) *using average path to netxt WP with slope 10%*

To determine the distances for various segments of the Standard Instrument Departure (SID) procedure, including turns, tangents, and along the track, AutoCAD provides valuable tools for precise measurements.

1. Distance Along a Turn:

AutoCAD allows for the calculation of the distance along a curved path by using its arc or curve measurement tools. By inputting the radius of the turn and the angle of the arc, AutoCAD can compute the length of the turn segment accurately.

2. Tangent Distance:

The tangent distance, which is the distance along the straight path connecting the start and end points of a curve, can be measured using AutoCAD's line and dimensioning tools. This involves drawing a straight line from the end of the curved segment to where it intersects with the next segment.

3. Distance Along Track:

For measuring the distance along the track, AutoCAD's line measurement tools can be employed to calculate the distance between waypoints or along the defined flight path. This is especially useful for ensuring that the SID complies with required distances and clearances.

By leveraging AutoCAD's precision tools, these distance calculations are performed with high accuracy, supporting the development of an effective and safe SID design..

g. *Gain TNA to Fix*

Dist. Along track x 10%

29.046,77 x 10% = 29 046 m (95.297,8 ft)

l. *Highest expected altitude*

TNA + Gain TNA to HLM

550 + 95.297,8 = 95 847

m. *Cons. Level 1st Turn*

$= (\frac{Dist.Along\ track\ x\ 4{,}8\%}{0{,}3048}) + TNA$

$= (\frac{29\ 046\ x\ 4{,}8\%}{0{,}3048}) + 550 = 5\ 124$ ft (1 561m)

h. Altitude Aircraft from Intercept Route to HLM

= Alt. Intercept route + (Dist. Intercept to HLM x 4,8%)

Dist. Intercept to HLM 15,684 nm = 29.046,77 m

= 1 516 +(29.046 x 4,8%)

=2910,208 m = 9.547,927 ft

So the altitude aircraft in HLM is above altitude 9 500 feet

7. *Protection VOR* HLM

a.*Zv :* h x Tan α

h: 9500 ft = 2,8956 km

2,8956 tan50^0 = 3,45 km = (1,862 nm)

b. qv : Zv sin 5^0

3,45 sin 5^0 = 0,3006 km = (0,162311 nm)

c.Draw 2 lines with an angle of 5^0 from the VOR

d. determine the points V1 and V2 at the intersection of the circle radius and then splay 5^0

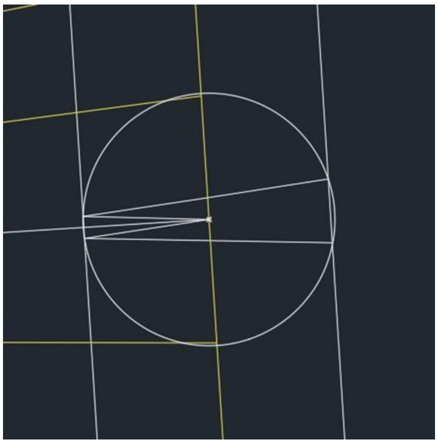

Figure 10. Protection VOR. Author (2024)

After take-off, the aircraft will climb to an initial altitude of 550 feet. Following this, the aircraft will execute a left turn to intercept the 090° radial from the BTO VOR (VHF Omnidirectional Range) and proceed towards the HLM VOR/DME (Distance Measuring Equipment). During this phase, the aircraft will maintain a cruising altitude of 9500 feet.

To ensure safe vertical separation and adherence to established safety margins, the departure procedure mandates a minimum Path Design Gradient (PDG) of 4.8%. This gradient is crucial for maintaining adequate clearance from obstacles and ensuring that the aircraft can safely ascend while aligning with the required flight path and avoiding potential conflicts with other air traffic.

By following these instructions, the SID design will enhance the overall safety and efficiency of departures from Budiarto Airport, facilitating smooth transitions into the en-route phase while adhering to international standards and best practices.

Conclusion

Based on the conducted research, several key conclusions can be drawn regarding the design of the Standard Instrument Departure (SID) at Budiarto Airport, Curug, Tangerang:

1. Critical Need for Departure Procedure Design:
   The ongoing extension of Budiarto Airport's runway from its current length of 1823 meters to 2150 meters is a significant upgrade that will enhance the airport's capacity and its ability to accommodate a wider variety of aircraft, including larger models like the Boeing 737-800. This expansion necessitates the development of a comprehensive Standard Instrument Departure (SID) procedure. Currently, the absence of a formal SID means that the airport's operations are not optimized for the increased capacity and diverse aircraft types that the extended runway will support. Implementing a well-designed SID will ensure that the airport's operations are both efficient and safe, providing clear guidelines for aircraft departure and integrating seamlessly with the expanded runway facilities.
2. E nhanced Operational Safety and Efficiency
   The proximity of Budiarto Airport's runway 30 to Soekarno-Hatta Airport's runway 25—just 7 nautical miles apart—presents unique challenges in managing air traffic and maintaining safety. The introduction of the new SID is crucial for addressing these challenges, as it will help manage the increased traffic and avoid potential conflicts between aircraft departing from Budiarto and those operating within Soekarno-Hatta's

airspace. By providing a structured departure procedure, the SID will enhance operational efficiency and ensure that all flight operations are conducted safely, reducing the risk of accidents and improving overall air traffic management in the region

3. Improved Coordination with Soekarno-Hatta ATC
   Currently, there is a lack of formal procedures for the transfer of control between Budiarto Airport and Soekarno-Hatta ATC, which can lead to coordination issues and potential air traffic conflicts. The development of a new SID will address this issue by establishing clear and structured procedures for transferring control of departing aircraft. This will not only improve the efficiency of air traffic management but also enhance safety by reducing the likelihood of miscommunication and ensuring that all aircraft are properly managed as they transition between the two airports' airspaces. The SID will facilitate smoother and safer interactions between the ATC units at both airports, leading to a more organized and effective air traffic control system.
4. In summary, the design and implementation of a Standard Instrument Departure (SID) for runway 30 at Budiarto Airport are critical for accommodating the airport's expanded capacity and ensuring safe and efficient flight operations. By addressing the need for a formal departure procedure, enhancing safety and operational efficiency, and improving coordination with Soekarno-Hatta ATC, the SID will play a vital role in supporting the airport's growth and integrating it effectively into the regional air traffic system. This will ultimately contribute to a safer, more efficient, and well-organized aviation environment.

References

Airnav Indonesia Cabang Pembantu Curug. (2022). *Prosedur Operasi Standar Pelayanan Lalu Lintas Penerbangan. Aerodrome Control Service (TWR)*.

Airnav Indonesia Cabang Pembantu Curug. (2023). *Prosedur Operasi Standar Pelayanan Lalu Lintas Penerbangan (Kegiatan Pelatihan Terbang)*.

Direktorat Jenderal Perhubungan Udara. (2021). *Aeronautical Information Publication*.

Direktorat Jenderal Perhubungan Udara. (2019). *KP 209 Standar Teknis dan Operasi Peraturan Keselamatan Penerbangan Sipil Bagian 173 (Perancangan Prosedur Penerbangan)*.

International Civil Aviation Organization. Council. (2009). *Annex 4 Aeronautical charts : international standards and recommended practices*. International Civil Aviation Organization.

International Civil Aviation Organization. Council. (2016). *Doc 4444 Procedures for Air Navigation Services Air Traffic Management 16th ed*.

International Civil Aviation Organization. Council. (2018). *Annex 11 Air Traffic Services*.

International Civil Aviation Organization. Council. (2020). *Doc 8168 Aircraft Operations PROCEDURES FOR AIR NAVIGATION SERVICES Volume II − Construction of Visual and Instrument Flight Procedures*.

Menteri Perhubungan Republik Indonesia. (2014). *PM 41 Organisasi dan Tata Kerja Kantor Unit Penyelenggara Bandar Udara Budiarto*.

Menteri Perhubungan Republik Indonesia. (2017). *PM 65 Peraturan Keselamatan Penerbangan Sipil Bagian 170 (Civil Aviation Safety Regulation Part 170) Tentang Peraturan Lalu Lintas Penerbangan (Air Traffic Rules)*.

Menteri Perhubungan Republik Indonesia. (2024). *KM 33 Tatanan Kebandarudaraan Nasional*.