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Central transport hub: Designing the structure of flight procedures

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ABSTRACT

Every commercial airport in the world has its aeronautical navigation procedures, which help manage and control air traffic in the airport's operational area. The central transport hub (CPK – Centralny Port Komunikacyjny), as Poland's new international air transport hub, will be no exception. Based on the analysis of the topography and land use in the immediate and wider surroundings of the CPK, it was possible to design the general structure of the STAR arrival, SID departure and ILS approach procedures for all runways of the new airport. Based on international technical guidelines and standards of the ICAO and national standards of the Polish CAA and the PANSA, it was possible to establish the preliminary structure of 28 navigation procedures. They serve as a prelude to further efforts to optimise air traffic in the Warsaw region. In the longer term, they will help achieve CPK's strategic goals and ensure the continued development of Poland's air transport sector. Based on the established navigation procedures, four main anticipated traffic flows of aircraft to and from the CPK have been determined: the north-western direction, covering transatlantic routes serving the United States, Canadian, and Scandinavian markets; the south-western direction, including transcontinental routes serving the Western European and Southwestern European markets; the south-eastern direction, comprising intercontinental routes serving the Central European and Balkan Peninsula markets, as well as transcontinental routes serving the Turkish, Caucasian, Middle Eastern, Persian Gulf, and Indian Peninsula markets; and the north-eastern direction, consisting of intercontinental routes serving the Eastern European, Finnish, and Baltic States markets, and transcontinental routes serving the Central Asian, Chinese, Korean, and Japanese markets. All of the aforementioned traffic flows align with the current development strategy for the Warsaw Chopin Airport network connections (ICAO: EPWA) and are also in line with the development strategy for the leading national Polish carrier, LOT Polish Airlines.

Keywords: central transport hub, navigation procedures, ILS; STAR; SID, air transport.

INTRODUCTION

The organisation of commercial flights is a complex process that requires the coordination of economic, legal, and physical aspects [Johnston, 1963; Lee et al., 2019]. The air transport process itself, i.e. a chain of activities aimed at delivering passengers and cargo by air, involves organising and planning the flight, as well as the flight itself [Brandt and Nickel, 2019; Szabo et al., 2022]. This, in turn, begins with the initial preparations the aircraft, which are carried out on the ground. In any planned flight, several sections, or flight phases, can be distinguished [Sekine et al., 2024; Shin and Lee, 2023; Zelinski, 2014]:

- on-ground phase – this involves operations performed directly on the ground, utilising the airport's infrastructure. These include taxiing, take-offs, braking on the runway, and ground handling operations such as loading, unloading, aircraft preparation for flight, and pushback;
- departure – which occurs from the moment the machine's gear is lifted off the ground to the first point on the route. It includes the initial climb process along with the anti-noise procedures;
- en-route – from the first to the last point on the planned flight route. Depending on the route length, the aircraft's performance and physical parameters, and the planned cruising altitude, the route may include the top of climb (TOC) and the top of descent (TOD). This is usually the longest phase of the flight, during which the aircraft maintains a constant altitude;
- arrival – which lasts from the final point on the route to the point initiating the Initial Approach Fix (IAF) approach. In most cases, aircraft in this phase are in the process of descending, and the crew is preparing the aircraft for landing;
- approach – from the IAF point to the moment of touchdown. This is the final phase of the flight in the air, which includes both stabilisation and the landing process itself.

Obviously, for safety and optimisation reasons, each phase of the flight must adhere to the International Civil Aviation Organization (ICAO) regulations [FAA, 2025b]. In any case, commercial flights are planned and carried out along a strictly defined route, which is not a simple orthodrome between points A and B. During the en-route flight phase, the traffic takes place between the route points, either directly or along the predefined airways. For economic reasons, it is common practice to use so-called "directs", i.e. shortcuts that direct the aircraft to a certain point while bypassing others. The air traffic control (ATC) issues these orders after analysing whether the manoeuvre will not create a risk of collision with another machine and often result in aircraft not following the strictly defined routes in a complex flight plan [FAA, 2025a]. Nevertheless, flight planning itself must adhere to established guidelines, and such a route must be reported to the units responsible for airspace management in a particular country [FAA, 2025c].

The need for safe and efficient air traffic management in airport operating zones has led to the necessity of applying standardised airport-related navigation procedures. Nowadays, almost every controlled airport in the world has a network of routes that enable the efficient handling of arriving and departing aircraft. They are used in instrument flight rules (IFR) flights, i.e. in almost all commercial flights, and their design is based on the characteristics of modern air navigation systems. For arrivals to and departures from airports, the following are distinguished [Malarski, 2006]:

- Standard terminal arrival route (STAR) – which defines the arrival route from the final route point to the IAF initial approach position [Krummen et al., 2025].
- Standard instrument departure (SID) – which defines the departure route from the runway to the first point on the route [Bikir et al., 2025].

In addition to a standardised route for all aircraft, departure and arrival procedures can include information on height restrictions and speed limits above specific points. They can also include an optional holding manoeuvre. The procedures are designed by the entities responsible for managing the airspace of a particular country. Since the ICAO does not impose the complexity in advance, one can encounter simple routes between two points, while others could be paths with a large number of turns. In practice, from an operational perspective, the SID and STAR routes are not always strictly adhered to, and the issuance of direct-type orders by the ATC is also common [ICAO, 2025].

The approach phase and the landing itself are among the most critical moments of the entire flight. The safe bringing of an aircraft to the ground is also possible thanks to airport-related navigation procedures. Due to the proximity to the ground when approaching the runway, they are more precise than the SID and STAR procedures and more often specify altitude restrictions as well as horizontal and vertical speeds. Its type determines the characteristics of the approach procedure, and its classification is based on the type of navigation aid used. The following types of landing approaches are distinguished [FAA, 2022]:

1. Precision approach:

- instrument landing system (ILS) – based on two ground-based antennas that enable precise guidance in the horizontal (Localizer) and vertical (Glide slope) planes. This is the most

accurate and most common type of approach, which, depending on the category (CAT I, CAT II, CAT III), enables landing under minimal visibility conditions, and even, for CAT III, the performance of automatic landing (Autoland) [Öktemer and Kazan, 2023].
- ground-based augmentation system (GBAS) – based on the global navigation satellite systems (GNSS), the accuracy of which is adjusted using the readings from the ground-based antenna. This is a relatively new alternative to the ILS. It is not commonly used, and only certain airports in the world enable this type of approach to be carried out [Felux et al., 2013].
- precision approach radar (PAR) – a radar-assisted approach based on communication with the ATC. It is very rarely used in commercial civil aviation, actually only in emergencies, e.g. when the aircraft's primary navigation instruments are damaged [Shejbal et al., 2014].

2. Non-precision approaches:
- area navigation (RNAV) – based exclusively on GNSS systems, it requires appropriate aircraft equipment and positioning accuracy. It may be possible to implement in mountainous areas [Medeiros et al., 2012].
- very high frequency omnidirectional range (VOR)/distance measuring equipment (DME) – based on ground-based VORs and/or DME range finders [Bobick and Bryson Jr., 1972].
- non-directional beacon (NDB) – based on ground-based non-directional radio beacons. They are currently being slowly decommissioned and replaced by RNAV [Škvareková et al., 2021].
- localizer (LOC) – which only uses the guidance antenna in the horizontal plane of the ILS system [Yuan et al., 2021].

All of the procedures described above are provided to the flight crew in the form of standardised navigation charts. Information on the anticipated procedures, points and airways on the flight route is included in the general flight plan (Figure 1) and provided to the crew before boarding the aircraft.

The central transport hub (CPK) is Poland's new infrastructural project. Like most airports worldwide, it will have its navigation procedures. Hence, this article aims to propose the basic structure of departure, arrival, and landing procedures, as outlined in the technical standards and safety requirements currently in force in Poland.

METHODOLOGY

The methodology adopted for designing flight procedures at the CPK follows the framework defined by ICAO (PANS-OPS, Annex 14, Doc 8168) and national Polish regulations, ensuring both international compliance and local operational feasibility. The process was structured according to the following steps:
- Design assumptions – the project assumes the airport is classified as ICAO category 4F, with two parallel runways that enable simultaneous, independent operations. The airspace structure was planned with consideration for typical traffic flows, aircraft performance (including A380-class aircraft), environmental limitations, and maximum operational efficiency. The design was based on a top-down approach, from high-level route integration to final approach.
- Obstacle treatment – all procedures were developed concerning obstacle clearance requirements, including the analysis of transitional, inner approach, and outer approach surfaces. Special attention was given to the chimney in Guzów, where compliance with ILS CAT III required either surface gradient modification or obstacle removal. The aim

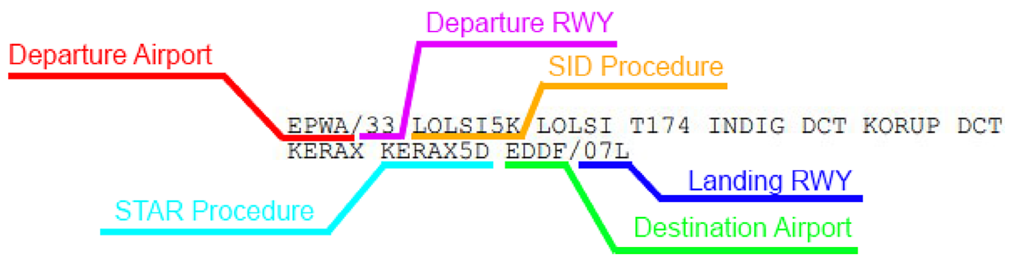


Figure 1. The en-route flight segment of a commercial flight is presented in the flight plan, where the points shown are route waypoints (five-letter codes), airway designators (letter + digit codes), and direct routings established in the plan (DCT)

was to retain precision approaches on all runways without downgrading categories.

- Regulatory framework – the procedures comply with:
  - ICAO: Annex 11, Annex 14, Doc 8168 (Volumes I-II), Doc 9157;
  - National: Polish Air Navigation Services Agency and Polish civil aviation authority (CAA) guidelines, Aeronautical Information Publication (AIP) Poland;
  - Supporting datasets: magnetic declination, terrain elevation (Geoportal), temperature data (Institute of Meteorology and Water Management – National Research Institute, IMGW-PIB), and wind analysis.
- Procedure development – the methodology involved sequential development of:
  - Precision approach procedures (ILS CAT IIIC) for all runways;
  - STAR based on regional traffic flows and airspace integration;
  - SID ensuring safe obstacle clearance and connectivity with en-route airways.
- Environmental and operational constraints – routes were optimised to avoid densely populated areas, protected zones (e.g., Kampinos National Park), and restricted airspace (P, R, D zones). Procedure geometries were adjusted to minimise noise impact and ensure interoperability with nearby airports (e.g., EPLL, EPMO, EPWA).

This methodology ensured a comprehensive, safety-driven, and regulation-compliant development of navigation procedures, enabling the CPK to operate efficiently in all weather conditions and under varying traffic demands.

METHODS

The CPK will be a large, international hub airport serving both the Warsaw metropolitan area and the entire country of Poland [Blachut, 2019; Duliński, 2025; Węgliński, 2019]. Its characteristics and strategic objectives, along with a brief history of the entire concept, were described by Nowoczyn and Specht [2025]. This information and, above all, the analysis of the new airport's operating environment was also used in this project.

Another basis for the following stages will be the airport itself. It is, therefore, necessary to learn about the proposed layout of runways, along with their parameters. Numerous factors determine the characteristics of runways, the most important of which include wind distribution, the topography of the airport and its surroundings, the type and volume of the air traffic handled, aircraft performance and environmental restrictions [ICAO, 2020b]. In the case under consideration, the airport is located in an area with no mountains or rough, uneven topography. Therefore, the main factor determining the orientation of runways is the average wind direction. Currently, the ICAO requires that the runway orientation enables the performance of operations in at least 95% of wind conditions. Since the maximum crosswind speed for the heaviest machines cannot exceed 20 kt, runways must be aligned with the prevailing wind directions at the particular location [ICAO, 2020b]. As far as Poland is concerned, winds from the east and the west are the most common, which translates into the orientation of the vast majority of airport runways in the country, and the CPK will be no exception.

As of today, the CPK has published the general geometric layout of the runways in the area development plan [CPK, 2025]. In the first phase of its operation, the new airport will have two parallel, identical runways with a centreline spacing of 2,688 m (Figure 2). The parallel layout is often seen at the world's busiest airports because it maximises the number of operations up to 200 per hour by allowing them to be carried out simultaneously on two runways [Horonjeff and McKelvey, 2020]. It also favours the simplification of the taxiway network and the smoothing of traffic.

By international regulations, for airports in the same category as the CPK, namely 4F, the minimum runway centreline spacing required for the performance of parallel operations should be 210 m under visual flight rules conditions and 1,035 m under IFR conditions [ICAO, 2020b]. This requirement has been met.

The rules for runway numbering in Poland do not differ from global standards and involve the rounding of the azimuth of their directions. It should be emphasised here that these are not geographical directions but magnetic ones, i.e. they are used with reference to the magnetic poles. This means that, to determine the direction of the runway, it is necessary to specify its geographical course adjusted by the magnetic declination (δ) value, which, in this area, is +6°49' (January 2025, Duninopol) [Magnetic Declination, 2025]. According to the presented area development plan, the basic geographical azimuth for the two

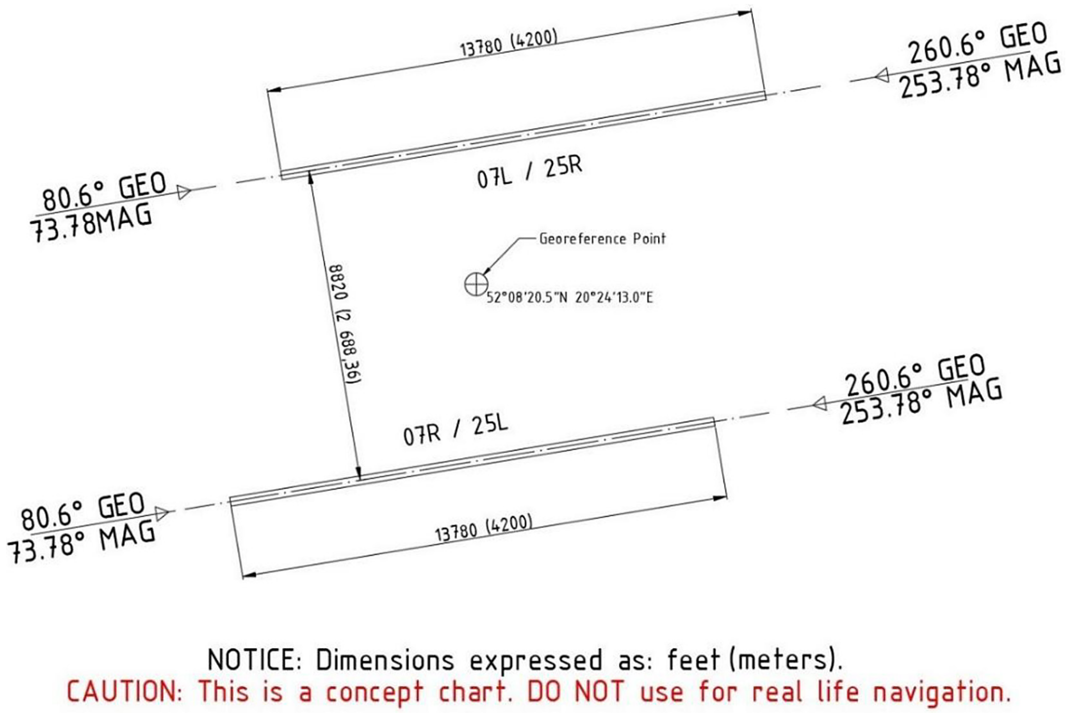


Figure 2. Layout of the CPK runways

parallel runways is 80.6°. Therefore, the magnetic heading (*MH*) is:

$$MH = 80°36 - (+6°49') = 73°47' \quad (1)$$

This means that the magnetic heading for the opposite threshold of the same runways is:

$$73°47' + 180° = 253°47' \quad (2)$$

By international numbering rules in force in Poland, the runways at the CPK are therefore designated as 07L/25R and 07R/25L [Horonjeff and McKelvey, 2020].

The last parameters required are the dimensions of the runways. According to the area development plan, both will have identical dimensions, i.e., a length of 4,200 m and a width of 75 m [CPK, 2025]. To understand the validity of selecting these parameters, it is necessary to examine the technical standards established by the ICAO. For example, for the 4F category airports, the width of the runway must be equal to or greater than 60 m [Malarski, 2006]. For the length parameter, the reference aircraft and its standard take-off run are used as the basis [ICAO, 2020b]. However, going one step further, one can consider the extreme case, i.e. the take-off run of a reference aircraft with a maximum take-off weight. For the 4F category, this is the Airbus A380, whose maximum take-off weight is 575 t [Airbus SE, 2021], and the length of take-off run under standard atmospheric conditions (OAT of +15 °C, 1013 hPa) is 3,200 m [Airbus SE, 2020]. This means that the length of the take-off run available (TORA) [Malarski, 2006] is:

$$TORA = 1.15 \cdot 3,200 = 3,680\,m \quad (3)$$

According to the terrain characteristics described in Nowoczyn and Specht [2025], the airport elevation is equal to 100 m above mean sea level (AMSL). At the CPK location, in the warmest month of the year, the average temperature is 21 °C, with an average temperature extreme of 32 °C [IMGW-PIB, 2025], which translates into the reference airport temperature (T_a), which is:

$$T_a = 21 + \frac{32 - 21}{3} = 24.67°C \quad (4)$$

According to Table 3-1 provided in Doc 9157, the standard atmospheric temperature at an altitude of 100 m AMSL is 14.35 °C [ICAO, 2020b]. Therefore, for the data above, the length of the runway, adjusted by the absolute height, is equal to:

$$\left(3,680 \cdot 0.07 \cdot \frac{100}{300}\right) + 3,680 = 3,766\,m \quad (5)$$

And the length is adjusted by the airport elevation and temperature:

$$\left[3,766 \cdot (24.67 - 14.35) \cdot 0.01\right] + 3,766 = 4,155\,m \quad (6)$$

Consequently, it can be stated that the runway dimensions of 4,200 × 75 m are correct and can provide a basis for further design work. The runway threshold elevations are [GUGiK, 2025]:

- for the RWY 07R, elevation = 98 m AMSL,
- for the RWY 25L, elevation = 95 m AMSL,
- for the RWY 07L, elevation = 95 m AMSL,
- for the RWY 25R, elevation = 92 m AMSL.

Additionally, for this paper, the central transport hub will receive the ICAO international working code of EPWX, as assigned by the organisation's guidelines for the region [ICAO, 2024].

RESULTS

After analysing all the aspects that may affect the structure of the CPK aeronautical procedures, we can move on to the design stage, where the ground-up principle will be applied. This means starting with the ground-based infrastructure and progressing through the subsequent airspace levels up to the navigation points that initiate the SID and STAR procedures. Before establishing any procedures, let us focus on determining two critical zones on the runways, namely the touchdown zone and the aiming point. These will be crucial areas when marking out the descent path during the design of the approach procedure. By the regulations in force in Poland, the touchdown zone should start at a distance of 150 m from the RWY threshold, and the total length of the runway determines its length, and for those longer than 2,400 m (the case under consideration), it is 900 m. The aiming point zone is found within the touchdown zone. It starts 400 m from the runway threshold and has a length of 45 m [Horonjeff and McKelvey, 2020; Malarski, 2006].

Designing the ILS landing procedures

The introduction describes the various types of landing approaches currently used. There are many of them, and most of the world's airports handling commercial traffic use more than one type. In all likelihood, the CPK will not be an exception in this respect. However, to proceed to the next design stage, namely the establishment of the STAR procedures, only the location of the IAF point needs to be determined. Therefore, for the purpose of this paper, we will limit ourselves to a single, and one of the most common, type – ILS Category III.

The instrument landing system is based on ground-based radio navigation aids. Radio beacons, positioned in an appropriate location, emit an electromagnetic glide path that is correctly received by the aircraft's antenna and transmitted to the aircraft crew via onboard equipment. The position relative to the standard descent path is obtained through the reading of the frequency modulation of the signals received from the antennas. During the ILS approach, three types of signals are used [Malarski, 2006]:

- localizer – signals emitted by a localiser transmitter located in the runway centreline, which enable correct positioning in the horizontal plane.
- glide path (Slope) – signals emitted by a glide path radio beacon located at an appropriate length of the runway, in the touchdown zone, which enable correct positioning in the vertical plane.
- marker(s) – are optional signals emitted by radio marker beacons located in the centreline of the approach strip at an appropriate distance from its threshold, providing information on the distance from the runway.

Additionally, the ILS system is categorised based on its usability, which varies according to the runway visual range (RVR). In any case, category II enables the landing at a visual range of at least 300 m at the moment of being positioned 30 m (100 ft) above the ground. For the IIIA category, RVR decreases to 200 m. As for the IIIB category, the landing operation can be performed at RVR of at least 100 m, at an altitude of 15 m (50 ft) above the ground. The highest category, IIIC, enables automatic landing with no visual restrictions [FAA, 2019]. Considering the nature of the CPK, it is necessary to ensure that the airport can operate without interruption under any visibility conditions. Therefore, we will focus specifically on the development of ILS CAT IIIC for all runways.

The most important aspect during the approach is to ensure that the aircraft has a minimum obstacle clearance (MOC). To identify it, obstacle identification surfaces must be determined. In the case of a precise approach, three interconnected surfaces are distinguished: the transitional surface, the approach surface and the inner approach surface [ICAO, 2021]. All of them must be free of obstacles. For the ILS I and II categories, the clearance heights are determined according to the aircraft category and are additionally restricted by the obstacle assessment surfaces. However, as for category III, the operations themselves secure the previously mentioned surfaces [ICAO, 2020a]. This means that, in this case, ensuring clearance requires checking whether previously identified obstacles penetrate the approach zones.

The transitional surface is a zone around the airway, which is divided into an outer zone, which must be free of buildings or other structures, and an inner zone, in which no obstacles, including vehicles, other aircraft or navigation aids, may be located. The base of the transitional surface is a rectangle, which, in the case of ILS CAT III, has a width of 280 m (800 ft) and a length equal to the length of the runway with an extension of 60 m (200 ft) on both ends [Horonjeff and McKelvey, 2020]. The surface of the base is located parallel to the runway surface. The entire zone rises upwards, with a side wall gradient of 14.3% [ICAO, 2021].

The inner approach surface has standardised dimensions, and, in the case under consideration, it begins at the boundary of the transitional surface, i.e. 60 m away from the runway threshold. It is 140 m wide and 900 m long. It is a two-dimensional plane with a gradient of 2% [ICAO, 2021].

The approach surface begins at the same point as the inner approach surface. It is also a plane but not a rectangle. The inner edge is 280 m wide. The lateral edges extending from it have a spread angle of 15°. This surface is divided into two parts. The first one is 3,000 m long, with a gradient of 2%. The second one, with a gradient of 2.5%, ends either at the intersection with the plane of the highest obstacle found on it or at the intersection with the plane located 150 m above the runway threshold (whichever is higher) [ICAO, 2021]. For all runways, all the surfaces will be very similar, with the main difference lying in the absolute limit heights. All of the dimensions provided in the surface characteristics are measured on a horizontal plane. This means that the following equation determines the actual length of the 3D geometric shape itself:

$$l = \frac{d}{\cos(\alpha)} \tag{7}$$

where: l – actual length in space, α – gradient angle, d – length of the plane.

Therefore, the actual length of the plane of the inner approach zone is:

$$l_{IAPS} = \frac{900}{\cos(1.15°)} = 900.18\,m \tag{8}$$

This means that its maximum height above the ground level is equal to:

$$h_{IAPS} = \sqrt{900.18^2 - 900^2} = 18\,m \tag{9}$$

The exact dimensions of the first part of the approach surface can be determined in the same way. Its actual length is:

$$l_{APS1} = \frac{3,000}{\cos(1.15°)} = 3,000.60\,m \tag{10}$$

The relative height of the highest point is:

$$h_{APS1} = \sqrt{3,000.60^2 - 3,000^2} = 60.22\,m \tag{11}$$

In addition, due to its trapezoidal shape, the width of the outer edge of this surface has a length of:

$$w_{APS1} = 280 + [2 \cdot \tan(15°) \cdot 3,000] = 1,887.7\,m \tag{12}$$

As for the second part of the approach surface, the situation becomes more complicated due to the lack of a fixed length, as the maximum limit height determines it. To establish it, one must first determine whether any obstacle higher than 150 m (492 ft) is found within the boundary distance of 15 km from the runway threshold. Drawing on the on-ground analysis of the CPK surroundings presented in Nowoczyn and Specht [2025], when looking at the obstacles designated in the operational zone, one can see that none are close to the centreline of any runway within 15 km of its threshold. The chimney of the Pruszków II CHP plant would come nearest to meeting these criteria, but it is located more than 20 km from the runway threshold. It can, therefore, be assumed that the end of the approach surface for each runway will be located at a height of 150 m above the runway's elevation. Thus, the height of the second part alone is equal to:

$$h_{APS2} = 150 - 60.22 = 89.78\,m \tag{13}$$

Which, in turn, means that its length on the plane is:

$$d_{APS2} = \frac{89.78}{\tan(1.43°)} = 3,596.47\,m \tag{14}$$

Its actual length is:

$$l_{APS2} = \sqrt{89.78^2 + 3,596.47^2} = 3,597.59\,m \quad (15)$$

Finally, the width of the outer edge of the entire approach surface is:

$$w_{APS} = w_{APS2} = 280 +$$

$$+ \left[2 \cdot \tan(15°) \cdot (3,000 + 3,596.47)\right] = 3,815.04\,m \quad (16)$$

Limit heights for the individual runways are summarised in Table 1, and their appearance is shown in Figures 3 and 4.

Once the exact dimensions and positions of all the planes have been determined, it can be checked whether they penetrate any obstacles. As for the RWY 07L, such obstacles could be buildings in the villages of Maurycew and Skrzelew. However, according to the area development plan, these buildings will be located within the airport's boundaries and are intended for demolition. For many of these houses, this has already happened (as of the end of 2024). Therefore, they are not to be considered. The situation is similar for the RWY 25R, where a large proportion of residential buildings in the villages of Wyczółki and Stara Pułapina are scheduled for demolition; for the RWY 25L, where a similar fate awaits houses in the village of Drybus; and for the RWY 07R, where several buildings in Janówek and Orzyszewo-Osady will be demolished. However, for this very direction, there is a structure of a considerable height within the horizontal limits of the surface, namely the historical chimney of the now defunct sugar refinery in Guzów, which is located at a distance of 2,787.6 m from the runway centreline and has a height of 59 m. Therefore, let us check whether penetration takes place, i.e. whether the obstacle height h_O (which is the sum of the height of the chimney and the elevation of

Table 1. Absolute limit heights of the identification surfaces for all the RWYs of the CPK

Runway	Altitude of inner approach surface[1]	Altitude of the 1st part of the approach surface[1]	Altitude of the 2nd part of the approach surface[1]
07R	116	158.22	248
07L	113	155.22	245
25L	113	155.22	245
25R	110	152.22	242

Note: [1] meters AMSL.

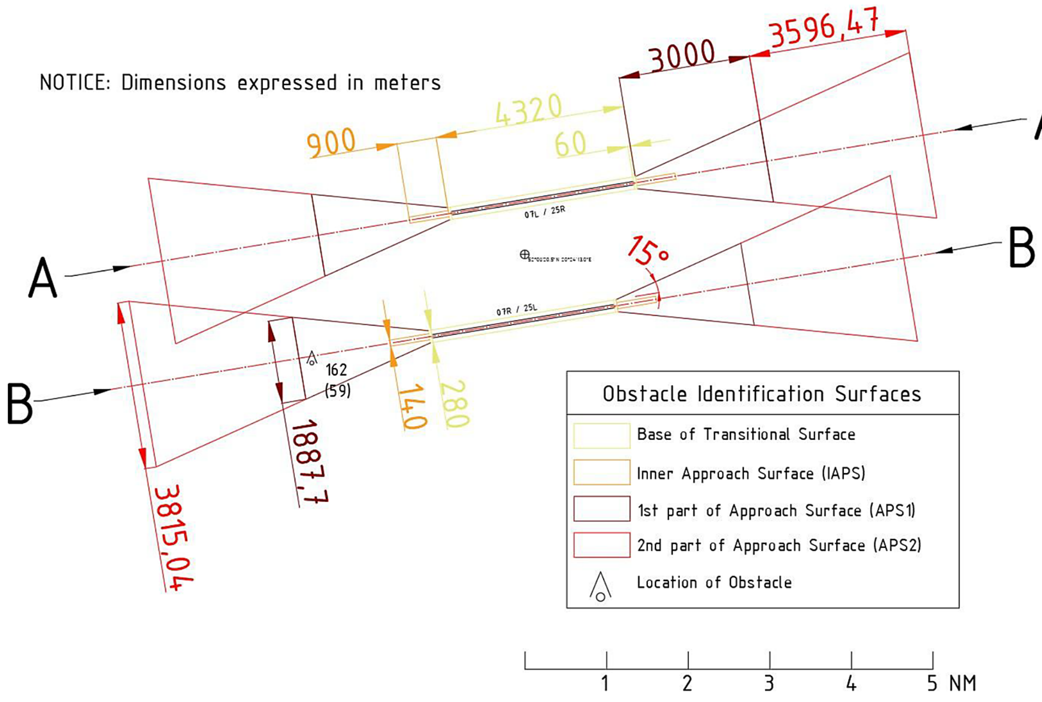


Figure 3. Obstacle identification surfaces for all the CPK runways. The obstacle shown in the diagram is a chimney of the defunct sugar refinery in the village of Guzów

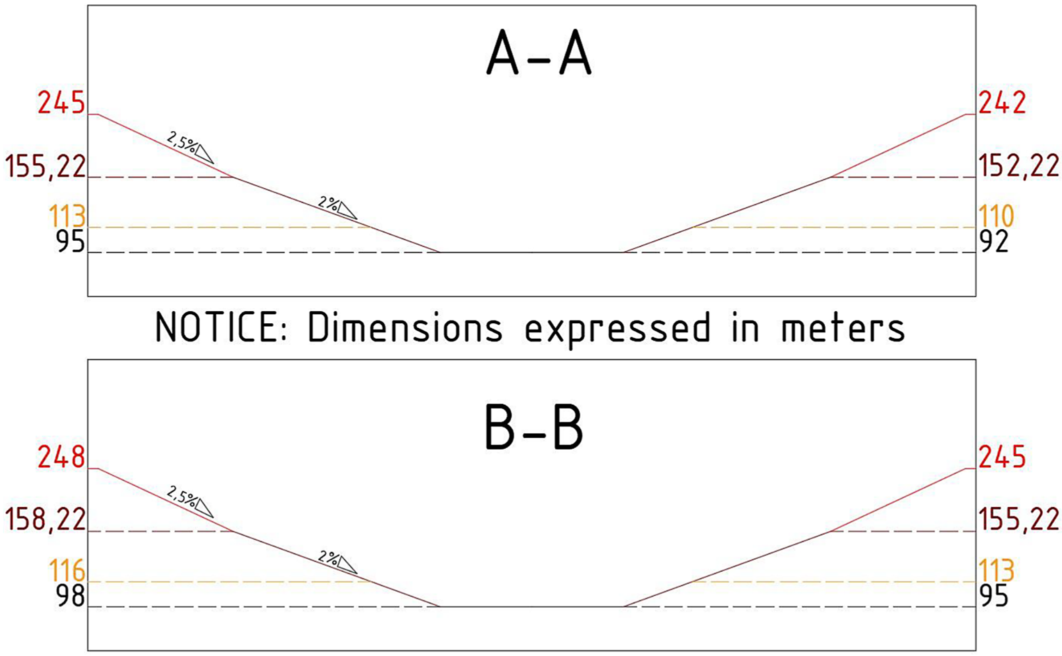


Figure 4. Diagram of obstacle identification surfaces for all the CPK runways. Vertical sections of the centrelines are marked on Figure 3

terrain about the elevation of the runway threshold), is greater than the approach surface height at the $h_{APS(O)}$ point:

$$h_O = 59 + (100 - 98) = 61m \quad (17)$$

$$h_{APS(O)} = (2,787.6 - 60) \cdot \tan(1.15°) = 54.75m \quad (18)$$

$$h_O > h_{APS(O)} \quad (19)$$

Therefore, the chimney in Guzów penetrates the approach surface.

Fulfilment of the “no penetration” condition means that a standard glide path angle of 3° can be applied. Where this condition is not fulfilled, there is a possibility for increasing the angle, but only up to a maximum of 3.5°. This change also means that the ILS CAT will be downgraded to the first category [ICAO, 2020a]. If penetration still occurs after adjusting the gradient of the approach surface, the obstacle must be removed. This analysis examines whether, for the case under consideration, a 0.5° increase in the surface gradient will increase its height at the obstacle point sufficiently for the Guzów chimney not to penetrate it.

$$h'_{APS(O)} = (2,787.6 - 60) \cdot \tan(1.65°) = 78.57m \quad (20)$$

$$h'_{APS(O)} > h_O \quad (21)$$

Therefore, it is evident that increasing the surface gradient, along with increasing the approach path angle, results in the chimney not penetrating it. What is more, when using analogous calculations, it can be concluded that it is sufficient to increase the angle by 0.2°, which results in the height of the surface above the obstacle equal to 64.27 m. To determine the ultimate values, it is recommended to conduct advanced computer simulations that select the angle at which the probability of collision is less than the accepted safety rules (maximum of one case per 10 million operations) [ICAO, 2020a]. However, considering the characteristics of the CPK, the abandonment of ILS CAT. III in favour of ILS CAT. I may contribute to the deterioration of the airport’s operational capabilities on directions 07R and 07L under limited visibility conditions. Therefore, a more optimal solution, as adopted for this paper, would be to demolish the chimney of the old sugar refinery in Guzów while maintaining ILS CAT III for the RWY 07R.

Once the conflict has been resolved, and it has been established that a standard descent path can be used on all runways, the final structure of the approach procedures can be determined. The paths will end in the designated touchdown zone on the runways at the beginning of the aiming point (400 m/1312 ft from the runway threshold). The start of the descent path is the final approach fix (FAF) point. It must be located within the precise range of the ground-based ILS radio beacons, i.e. no further than 11 km from the runway threshold. Therefore, the maximum height of the FAF point (h_{FAF}) in the case under consideration must fulfil the following equation:

$$h_{FAF} \leq \tan(3°) \cdot 11{,}000 \tag{22}$$

$$h_{FAF} \leq 576.49\, m \tag{23}$$

Therefore, considering the elevation of the runways, its maximum absolute height is equal to 670 m (2200 ft) AMSL when rounded to the nearest hundred. The FAF point must be located at an altitude which, according to the characteristics of the autopilot software in modern aircraft, must be a multiple of 100 ft. Considering the improvements in communication between the ATC and the flight crew and analysing the existing procedures for airports located in proximity to a similar area (EPLL, EPMO, EPWA), the FAF point can be set at 610 m (2000 ft) AMSL. At this point, the entire ILS CAT. IIIC procedure path for all runways can be outlined. The whole process involves connecting the previously determined navigation points, assigned to specific geographical coordinates, with straight sections. The five-character designations of the navigation points were selected by the rules defined by ICAO [ICAO, 2020a].

The ILS approach procedure paths for the individual runways are straight, and all the points contained in them lie in the runway centreline, with their structure being as follows:

- For the RWY 07L: The procedure starts at the IAF: BUZAR point, at which aircraft must maintain an altitude of 762 m (2500 ft) AMSL. Then, they descend along the path with a gradient of approximately 2.75% to an altitude of 610 m (2000 ft) AMSL at the WX 602 point. They maintain the preset altitude for 1.5 NM until the moment the ILS signal approach path is intercepted at the WX 601 point, which is an FAF.
- For the RWY 07R: The vertical and horizontal profile of the procedure is very similar to that for the RWY 07L. In this case, the IAF point is the SOKOS point, with the required altitude of 762 m (2500 ft) AMSL. Another point is WX 758, located at an altitude of 610 m (2000 ft) AMSL. Here, the FAF point is WX 759.
- For the RWY 25R: The procedure starts at the altitude of 610 m (2000 ft) AMSL at the IAF point: CUBIX. The next point is the FAF point: WX 821, located 1.5 NM further, at which aircraft intercept the ILS path. This procedure is shorter than those for the directions 07R/L to avoid the performance of flight operations above densely populated residential areas of the Warsaw metropolitan area.
- For the RWY 25L: A similar case to that for the RWY 25R. The short procedure starts at the altitude of 610 m (2000 ft) AMSL at the IAF point: KOTOW, with the second point already being FAF: WX 985.

The shape of the above-described procedures is shown in longitudinal section at Figures 5 and 6, and in cross section at Figure 7.

Designing the STAR arrival procedures

Provided that we have determined the ILS landing procedures, including all the IAF points, we can proceed to design the STAR procedures. These will be marked out for the four main arrival directions for the CPK. To begin with, we will determine the starting points for each direction of arrival. These will be publicly available navigation

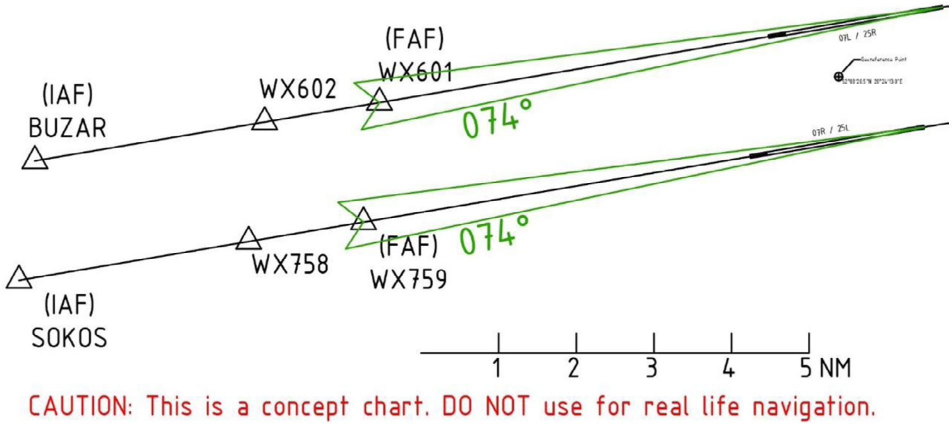


Figure 5. ILS CAT IIIC procedures for runways 07L and 07R

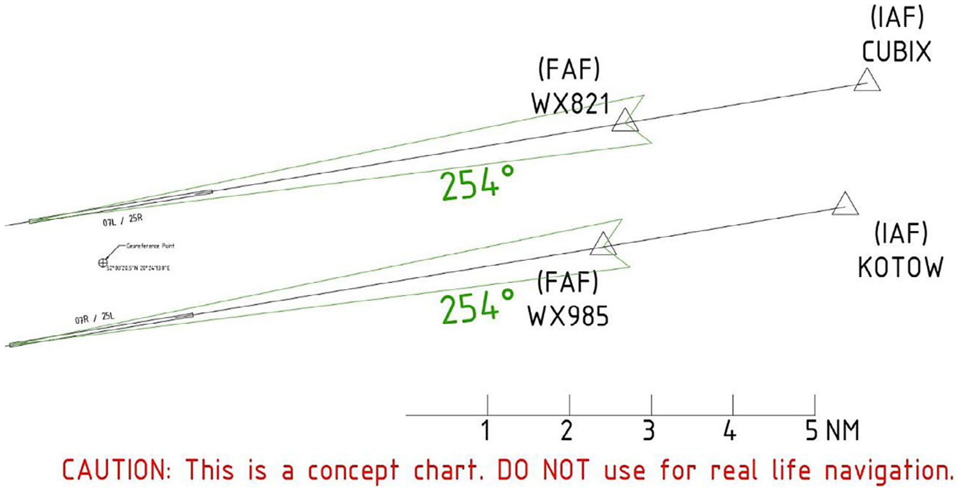


Figure 6. ILS CAT IIIC procedures for runways 25L and 25R

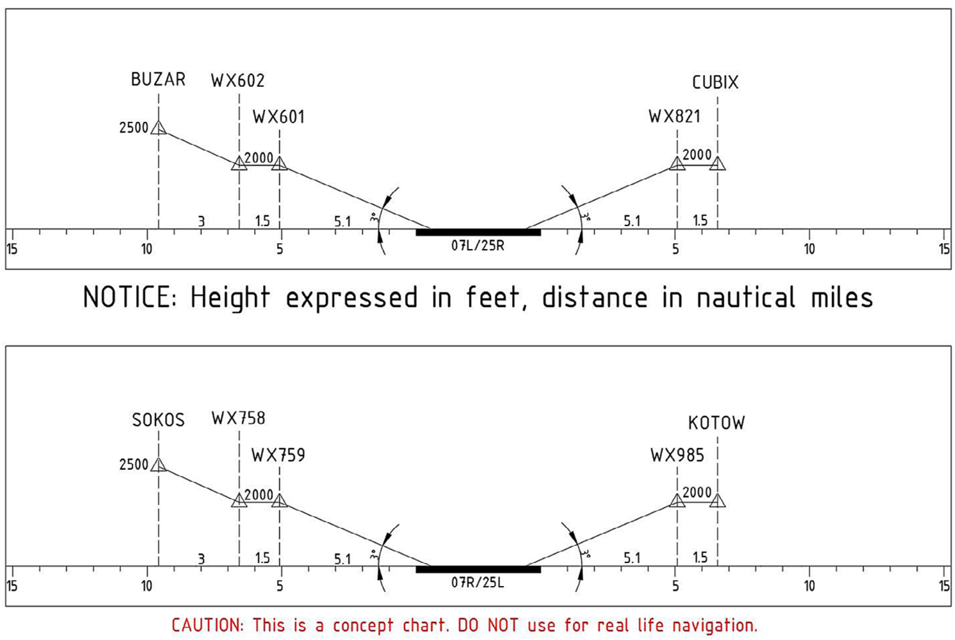


Figure 7. Diagram of the approach path profile for the ILS CAT IIIC procedures for all the CPK runways

points belonging to Poland's airway network. For each of them, there should be the possibility of arriving along airways from positions located on the borders of Poland's airspace. These are also important in the context of the nomenclature of the entire procedure, which appears in the format XXXXX.1Y, where "XXXXX" stands for the name of the navigation point that initiates the procedure, or another significant one, "1" symbolises the number of consecutive versions of the procedure (from 1 to 9), and "Y" is a unique coding letter [ICAO, 2018a].

For example, for the north-eastern direction, the appropriate point at which to start the procedure will be the SUTIK point. It is located at the intersection of the N5 and M985 airways, which ensure a direct connection to the airspace of the Russian Federation and Lithuania, respectively. In addition, the SUTIK position can be easily reached by air from the T174 and P851 airways, which run from the border with Belarus. The south-eastern direction will be optimally handled from the point defined as ODRUX. It is located on the T137 airway, which, in turn, provides access to such airways as M860 and L980, which, in turn, are connected through the boundary points with Ukraine's airspace. In addition, due to the concentration of multiple intersections with other airways within this area, it is very easy to reach the ODRUX position by air from Slovakia's airspace. The direction with the most significant expected traffic volume is the south-west. Most aircraft flying from this area will take the N871 airway. It is directly connected through the boundary point with the Czech Republic's airspace, yet it is also possible to reach it from the territory of the Federal Republic of Germany. The optimal point at which to start the STAR procedure from this direction is the OKENO point. The final direction is north-west. In this case, the situation is complicated by the fact that this procedure will be used by aircraft operating transatlantic and intercontinental routes from Sweden, Norway, Denmark, as well as from Germany, the United Kingdom, and the Benelux countries. It is, therefore, reasonable to apply a so-called transition here, which involves concentrating the arrival routes from several points. In this case, the aircraft coming from the west use the P851 airway, which is directly connected to Germany's airspace. The optimal point for them is VEMAL. The aircraft coming from the north-west direction use transitions between the airspaces situated above the Baltic Sea, i.e. those of Denmark and Sweden. Many airways from these directions converge at the VOR/DME GRU radio beacon/range finder. From this point, one can take the N133 airway to the PENEX point. Specifically, the VEMAL and PENEX points will serve as the transitions, and the paths leading from them will merge at the newly created GOSTA position [PANSA, 2025].

Once the starting points have been established, we can move on to the stage of marking out the centre path. There are no strict rules for marking it out or determining its degree of complexity. In Poland, however, more circuitous STAR procedures are applied [PANSA, 2025]. This measure is intended to improve the organisation and separation of traffic in cases of high traffic volume. In typical operation, direct-type orders are used to shorten the distance. However, in the event of a higher traffic volume, for example, every second aircraft can be ordered to shorten the route while the others can carry out the whole procedure. Such a measure increases safety, optimises ATC operations, and reduces the risk of the aircraft going around due to a lack of runway clearance.

For the CPK procedure project, we will assume that the priority, when determining centre paths, will be to avoid the areas specified, ie. nature conservation sites, high population density, aviation obstacles, and the P, R, and D air zones. For the RWY 07R/L directions, we have designated the following STAR procedures (Figure 8):

- GOSTA.1A, with a transition PENEX and VEMAL,
- SUTIK.1A,
- OKENO.1A,
- ODRUX.1A.

When detailing the course of the route for procedures GOSTA.1A and SUTIK.1A, it is possible to use shortcuts from the WX 652 point to WX 604, WX 756, or even directly to IAF for the RWY 07L or 07R. The situation is similar for the OKENO.1A and ODRUX.1A procedures, where it is possible to perform this manoeuvre from the RAVAM point. The line of the OKENO-GOGUS-KOMDA route has been marked out specifically to avoid the Łódź metropolitan area and the EPLL airport area. The location of the points on the DINRI-GABIN route ensures that operations are not carried out above the protected area of the Kampinos National Park. The RABAT, WX 604 and WX 756 points were specifically located to minimise the adverse impact of aircraft on the inhabitants of the town of Łowicz and, in addition, to ensure adequate separation from the obstacle, namely, the longwave transmitter mast in Łowicz. The height restrictions have been selected in such a way as not to exceed the maximum gradient of descent, being identical to that for the initial segment of non-precision approach procedures, which is 6.1% [ICAO, 2018b]. This means that for all the points, the following conditions must be met:

$$h_{P2} \le d_{P1-P2} \cdot \tan\left(3.49°\right) + h_{\max(P1)} \quad (24)$$

where: h_{P2} – altitude at the point, $h_{max(P1)}$ – maximum altitude at the preceding point, d_{P1-P2} – distance between the points.

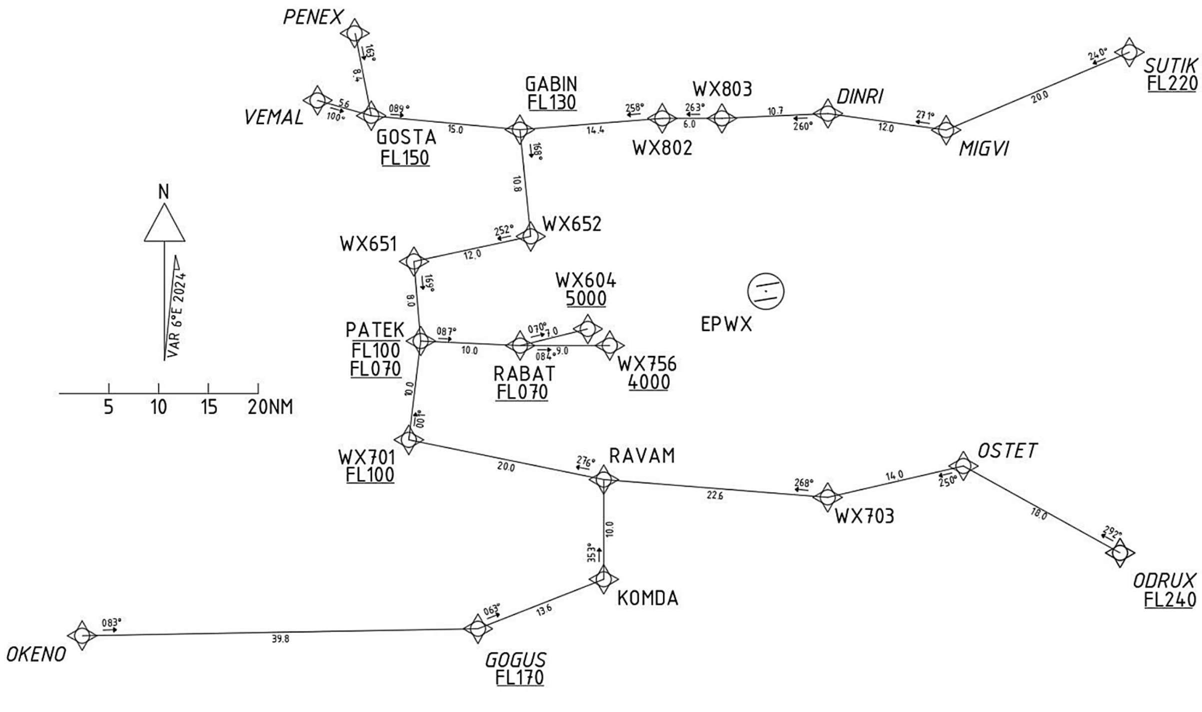
At this point, it is also worth mentioning the differences between heights expressed in numerical format and the flight altitude expressed in hundreds of feet, with the letter prefix "FL". The rules for their application are linked to the transition altitude, which means the transition of the altimeter setting from local pressure (QNH) to standardised pressure (STD), equal to 1013 hPa. This change arises from the need to obtain accurate height measurements in operations carried out at ground level and their lack at higher altitudes. The transition altitude is determined by the highest point and the associated minimum safy altitude (MSA), which are found in the territory of a particular state. In

Poland, it is equal to 1,981 m (6,500 ft) AMSL [PANSA, 2025]. Above this altitude, the FL flight levels are applied.

The height restrictions at the WX 604, WX 756 and RABAT points are intended to protect the acoustic and natural environments of the town of Łowicz and the Bolimów Landscape Park, as well as ensure safe obstacle clearance above the Łowicz longwave transmitter mast. Enforcing the maintenance of the flight level between FL070 and FL100 ensures safe vertical separation with the EPLL airport SID and STAR procedures occurring at this point, as well as at points WX 701 and GOGUS. In turn, the restriction at ODRUX helps avoid conflicts with the procedures for EPRA and EPMO. Along the course of the SUTIK.1A path, there are restrictions at the SUTIK and GABIN points. Their purpose is to enforce the glide path of aircraft in such a manner that they do not come into conflict with the CTR or the EPMO airport operational zone and its procedures. For runways 25L and 25R, the STAR procedures start at the same points. The difference, in this case, lies in the path course and height restrictions (Figure 9). The following designations will be assigned to them:

- GOSTA.1D, with a transition PENEX and VEMAL,
- SUTIK.1D,
- OKENO.1D,
- ODRUX.1D.

Since it is necessary for these two runways to route the approach from the east, i.e. above the Warsaw metropolitan area, to minimise the impact of aircraft on the environment and avoid the restricted airspace of the Kampinos National Park, we will route the northern approach path in a narrow corridor above the Warsaw district of Bielany, between the points IAF, BELOM and MIGVI. From the south, the central airway line is designed to bypass the nature conservation areas south of the A2 motorway. Due to the numerous urban areas, nature reserves, restricted zones and SID and STAR procedures of other airports, the approach procedures for the CPK for the RWY 25L/R include no additional turns. The restrictions for aircraft at the GOGUS, ODRUX, and SUTIK points have bases for their establishment similar to those for the STAR procedures for the RWY 07L/R, as described above. The restrictions at the DINRI and GABIN points are dictated by the need to ensure safe vertical separation above the operational zone of the Warsaw Modlin Airport (ICAO: EPMO).



CAUTION: This is a concept chart. DO NOT use for real life navigation.

Figure 8. Diagram of the STAR GOSTA.1A, SUTIK.1A, OKENO.1A, ODRUX.1A procedure paths for the RWY 07R/07L

Designing the SID departure procedures

With the STAR arrival procedures established, we proceed to the final stage of the design phase, which involves marking out the SID centre paths. As previously determined, these will be airways leading from the departure end of the runway (DER) to the final point of the procedure, located on one of the country's airways. The entire SID procedure is divided into two segments: departure and en-route flight. The former is carried out within the zone, which is at the most significant risk of collision with obstacles. It is characterised by an average glide gradient of 3.3% and the presence of obstacle identification surfaces (OIS). Two types of the departure segment are distinguished [ICAO, 2020a]:

- straight departure is one in which no turn greater than 15° can be made,
- turning departure.

The en-route flight segment begins when the adopted procedure gradient reaches the minimum altitude approved for the next phase of the flight. From this moment onwards, the adopted procedure gradient is equal to 7% [ICAO, 2020a]. As the CPK is located in an unrestricted area, and the orientation of runways results in the absence of densely populated or environmentally protected areas in their centrelines, it is possible to determine the departure segment as the straight departure. In such a case, the OIS for all runways will have an almost identical shape to that of the obstacle identification surfaces. The only difference will be the constant gradient of 2.5% and their beginning at the DER point, which is located 600 m before the threshold of each runway [ICAO, 2020a]. Considering these adjustments, one can come to the same conclusions regarding the obstacles as those provided in the subsection above (assuming the demolition of the chimney in Guzów). This means that the "no penetration" condition will be maintained along the entire length of the OIS surfaces, which, in turn, allows the standard procedure gradient to be applied. We also assume that the end of the departure segment is located at an altitude of 610 m (2000 ft), which means that the location of the endpoint satisfies the following equation:

$$d_{DSE} = \frac{609.6}{\tan(1.89°)} - 600 = 17{,}873\, m \tag{25}$$

where: d_{DSE} – the distance between the endpoint of the departure segment and the runway threshold.

The located end points of the departure segment will, at the same time, be the starting points

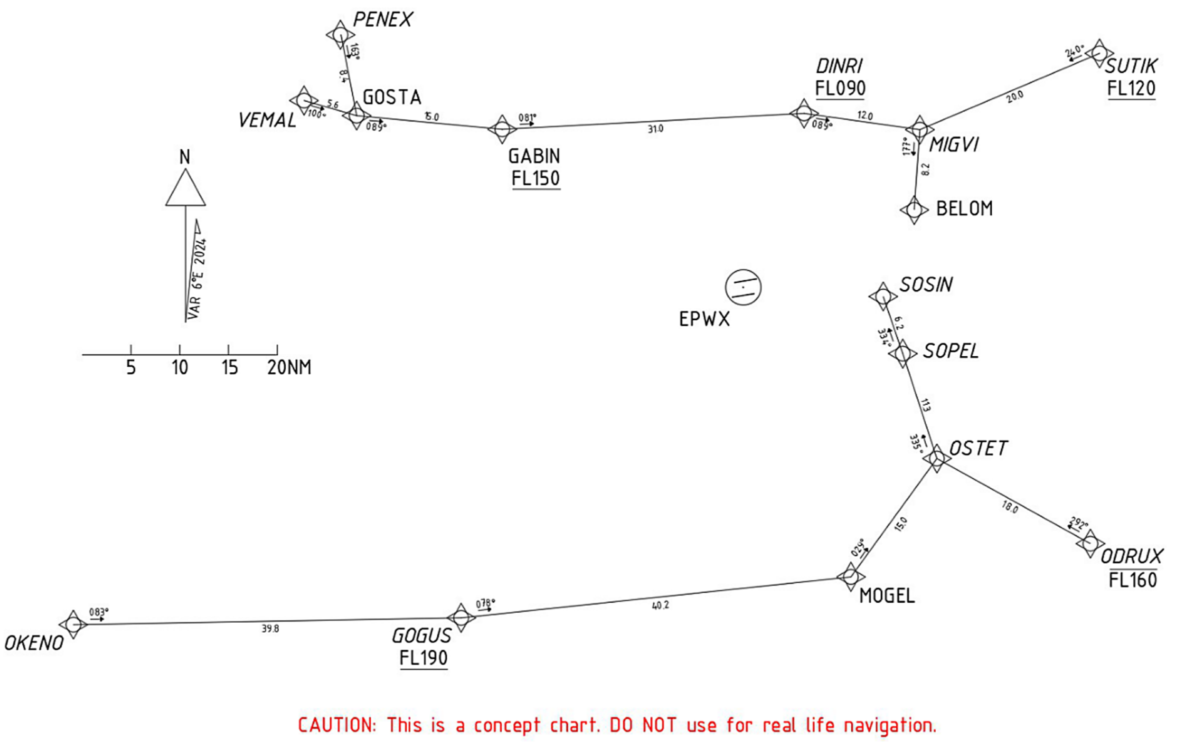


Figure 9. Diagram of the STAR GOSTA.1D, SUTIK.1D, OKENO.1D, ODRUX.1D procedure paths for the RWY 25R/25L

of the en-route flight segment of the procedure. In contrast, the end of this segment will be located at the positions found within the country's airway network, in the same direction as the previous STAR procedure. However, it is essential to make sure that these are not the same navigation points assigned to the CPK arrival procedures. Therefore, the following points are set out:

- For the north-east direction, the final point of the SID procedure will be BAMSO, from which it is possible to enter the Z182 airway towards Belarus and then the M857 airway, which is directly connected to Lithuanian airspace.
- For the south-east direction, the final position will be EVINA, from which it is possible to take the M66 airway directly to Slovakia, and also easily reach the airways leading to Ukraine.
- The south-west direction will be handled by the VAMPU point located on the N869 airway. Furthermore, a direct connection to the Czech Republic's airspace and an indirect connection to the Federal Republic of Germany are still provided.
- For the north-west, the optimal point is RILAB. The L621 airway, which goes from that point, can lead to the VOR/DME GRU radio beacon, from which numerous airways to the airspaces of Germany, Denmark and Sweden branch off.

When designing the SID procedure paths, the aim should be to move the departing aircraft out of the airport's airspace as quickly as possible. In addition, gliding aircraft usually reach a higher vertical speed than the descending ones. Moreover, less importance is attached to maintaining the IAS speed. Therefore, in contrast to the STAR procedures, we will aim for the simplest possible layout with no unnecessary turns. As the SID procedures lead directly from the runways, each runway will have its unique procedure, which will also be reflected in its name. Therefore, for the RWY 07R, we propse the following designations:

- BAMSO.1G,
- EVINA.1G,
- VAMPU.1G,
- RILAB.1G.

For the RWY 07L, the following designations are suggested:

- BAMSO.1H,
- EVINA.1H,
- VAMPU.1H,
- RILAB.1H.

For the opposite direction of RWY 25L, these will be as follows:

- BAMSO.1L,
- EVINA.1L,
- VAMPU.1L,
- RILAB.1L,

And for the RWY 25R:

- BAMSO.1M,
- EVINA.1M,
- VAMPU.1M,
- RILAB.1M.

In practice, the procedures for the exact directions will only differ in the departure segment and the airway from the first point of the en-route flight segment.

Marking out the paths for the directions 07R/L is complicated due to the need to bypass the Warsaw metropolitan area. For this reason, one should head for the BELOM or SOSIN position immediately after passing the WX 211 or WX 471 points. It should also be emphasised at this point that a significant obstacle, namely a chimney of the Pruszków II CHP plant, is located in the immediate vicinity. As its height reaches 341 m (1119 ft) AMSL, it is essential to emphasise the need to reach an altitude of at least 610 m (2000 ft) AMSL at the WX 211 and WX 471 points, which will guarantee minimum safe obstacle clearance of more than 61 m (200 ft) [ICAO, 2020a].

The BELOM and SOSIN positions are established for reasons similar to those for their inclusion in the STAR procedures for the RWY 25L/R. This concerns the transfer flight between protected areas and the densely populated ones. At the BELOM point, the shared path for BAMSO.1G/1H and RILAB.1G/1H branches off to the KLEBA and SUBEG positions, respectively. The height restrictions introduced at these points are intended to avoid conflicts with both the previously designed STAR procedures for the CPK and the airport-related procedures, as well as the operational zone of the EPMO airport. The same applies to the restriction at the RODEV point.

In the case of EVINA.1G/1H and VAMPU.1G/1H, their shared path ends at the VOLKO point and leads to ABSEL and ERMIV, respectively. The centre path of the VAMPU.1G/1H procedures is explicitly arranged to bypass the Łódź metropolitan area and the operational zone of the EPLL airport. However, it conflicts with the SID and STAR procedures for this airport, as well as with the STAR procedures proposed for CPK. To this end, restrictions have been introduced at the FORSA point, where the FL160 will be sufficient to fly over the ones above. Due to the intersection of the STAR routes for the CPK, aircraft are not allowed to ascend above the FL140 at the ERMIV point. In contrast, the application of restrictions at the EVINA point is dictated by the need to fly over the airport-related procedures for the Radom airport (ICAO: EPRA). Figure 10 illustrates the complete shape of these SID procedures.

For the 25L and 25R runways, the departure segment ends at points WX 331 and WX 101, respectively. At this point, the aircraft must also reach at least 610 m (2000 ft) AMSL, but this is not as important as the endpoints of the departure segment for the opposite directions, as there are no obstacles at this point. From these positions, the SID procedures branch off to the KEMSU point and further on to REMPA (RILAB.1L/1M) and ELGAD (BAMSO.1L/1M). The introduced ban on climbing above FL080 at the KEMSU and flying below FL130 at the ELGAD is intended to protect against collisions with the EPMO and STAR airport-related procedures for the RWY 25R/L of the CPK.

From the WX 331 and WX 101 points, the airways connect to the VIZAD position, which is located in such a place as to move the aircraft route as far away from the town of Łowicz as possible. At this point, the procedures lead straight to the two endpoints. One of them is the VAMPU (VAMPU.1L/1M procedure), at which, due to the intersection of procedures for the airports in Modlin (ICAO: EPMO) and in Łódź (ICAO: EPLL), the need to maintain the flight altitude between FL100 and FL140 has been introduced, which ensures the transfer flight between the conflicting paths. The second endpoint is EVINA (EVINA.1L/1M), which overlaps with the procedures for EPRA. What is more, the airway leading to the EVINA crosses the STAR designed for the CPK. As the introduction of a restriction identical to that at the EVINA.1G/1H would involve

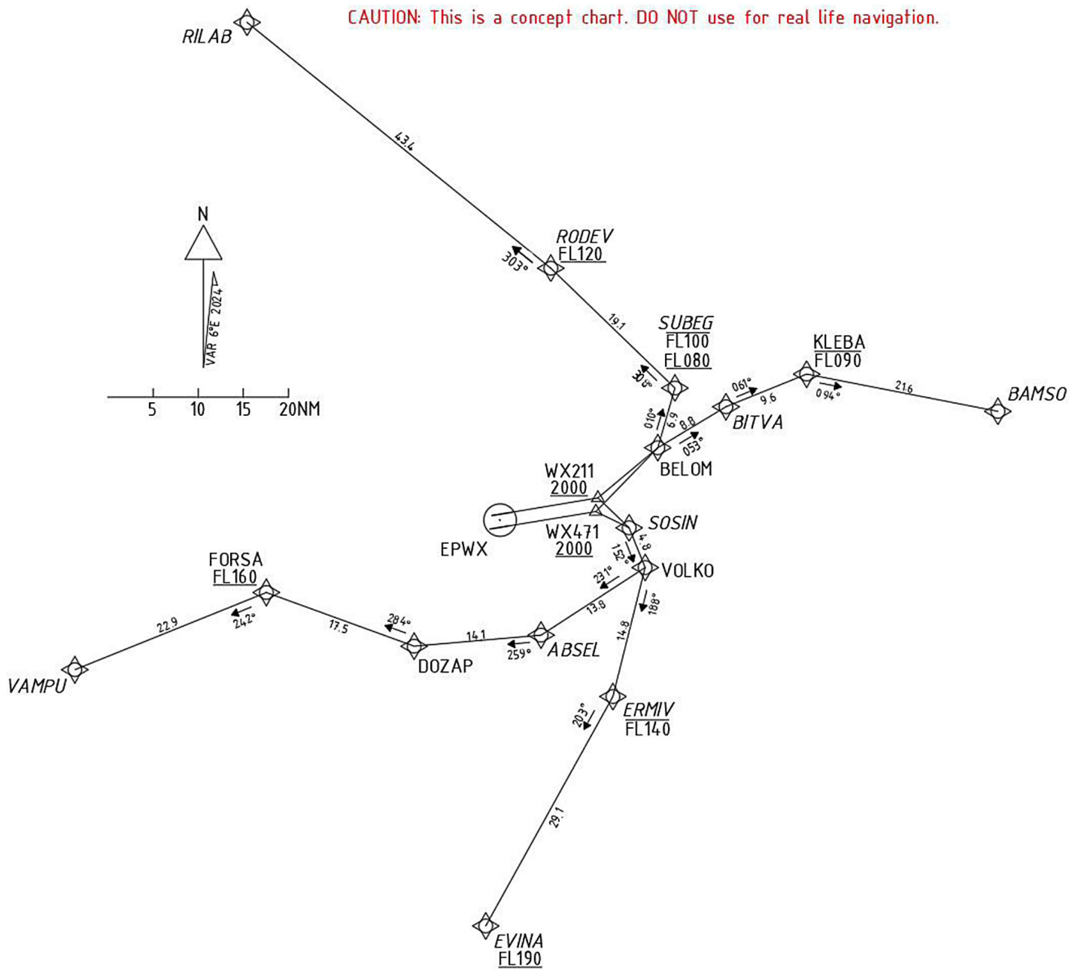


Figure 10. Diagram of the SID BAMSO.1G/1H, EVINA.1G/1H, VAMPU.1G/1H, RILAB.1G/1H procedure paths for the RWY 07R/07L

a risk of collision, we will apply, at this point, the obligation to perform a transfer flight between FL110 and FL130, which, at the same time, will ensure transfer flight under the conflicting STAR procedure, and above the procedures for the Radom airport (ICAO: EPRA). The climb to the cruising altitude will take place once this point has been passed. Figure 11 shows the shape of SIDs for RWY 25R/L.

DISCUSSION

The procedure paths, as proposed in this paper, are centre paths which show the basic view of their overall structure. Before initiating the implementation process, it would be advisable to additionally determine the structure of primary and secondary zones at individual points and the sections between them, as well as detailed designs of internal and external turn zones, considering IAS speeds and aircraft categories. This, among other things, should serve as a basis for introducing speed limits at specific points. It should be emphasised here that, to increase the versatility of the SID and STAR procedures, such restrictions should be implemented as a last resort. The paths marked out in the previous subsections have been specially designed to avoid this necessity. For example, no angles more acute than 90° have been used, and, in most cases, obtuse angles have been used. In addition, the focus was placed on ensuring that the distance between parallel airways is, in most cases, greater than 10 NM, which, in theory, should allow heavier, less manoeuvrable aircraft to make a turn with ease. In addition, standardised procedures for the departure after a missed approach, as well as the horizontal speeds achieved depending on IAS speed during the approach, should be established in the approach procedures. These aspects are highly detailed and should be designed by the ICAO international guidelines

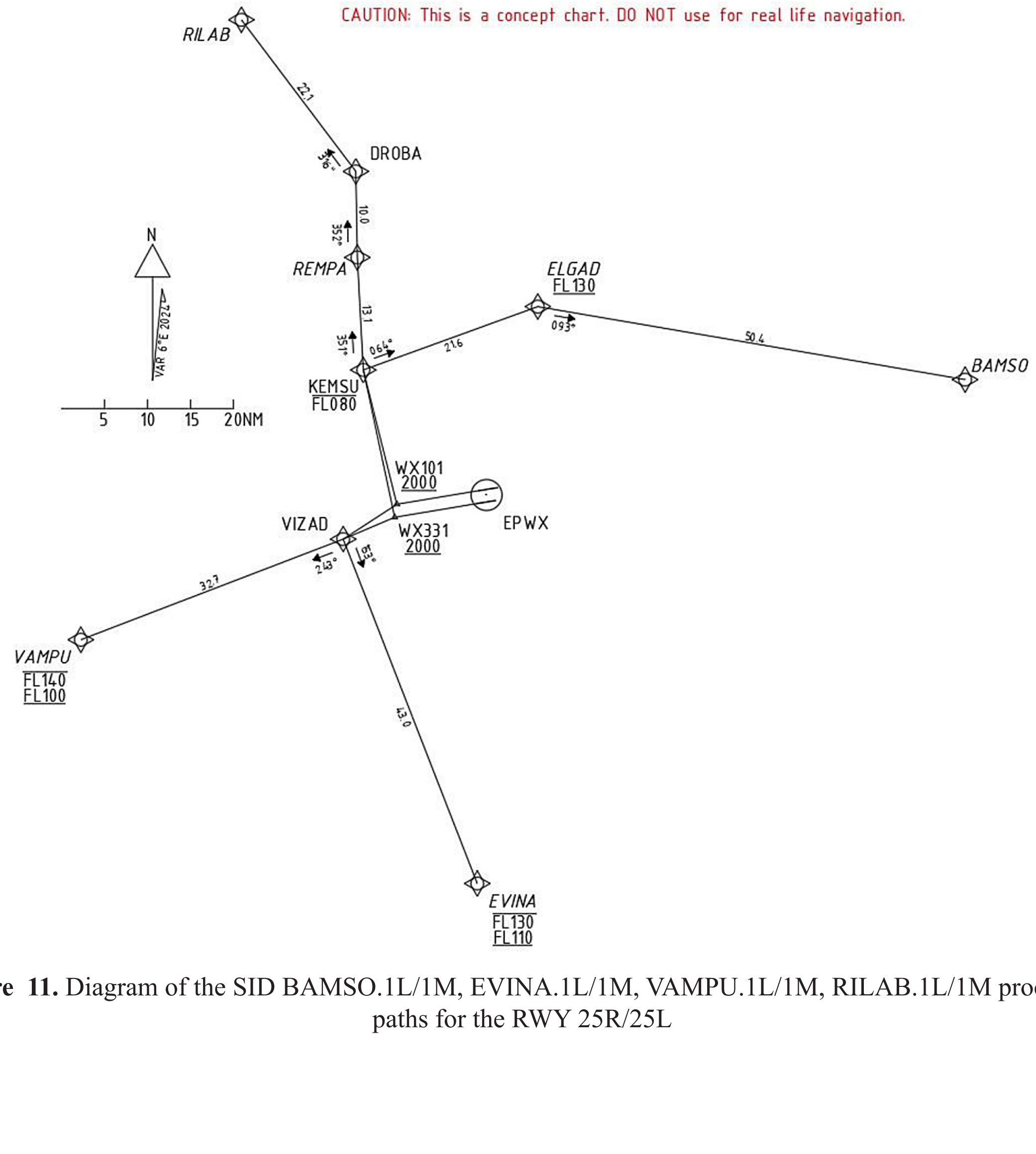


Figure 11. Diagram of the SID BAMSO.1L/1M, EVINA.1L/1M, VAMPU.1L/1M, RILAB.1L/1M procedure paths for the RWY 25R/25L

contained in the three volumes of Doc. 8168. Due to the excessive range of these aspects, these activities will be addressed in a separate paper.

Before any publication, all projects should undergo certification and authorisation by state administrative bodies dealing with airspace monitoring and organisation. For quality assurance purposes, each new or revised procedure should be verified by an appropriately qualified person or group of people other than those involved in the design process. Authorisation is obtained through validation from both the ground and the air. The purpose of validation is to determine the compliance of the situation presented with reality and to identify potential errors and inconsistencies. The correctness of the identified obstacles and navigation data is verified on-site during the design process. In cases of significant modifications and the introduction of new procedures, when deemed necessary, validation from the air is carried out based on actual test flights. Flight validation should also be carried out periodically to ensure that quality standards are met and maintained. The flight assessment encompasses obstacle clearances, compliance with navigation data, elements of physical infrastructure (designations, frequencies, lighting, etc.), procedural safety and operability, the accuracy of cartographic data, visibility range, and other operational factors. During the entire authorisation phase, it is possible (and even recommended) to use auxiliary tools, such as advanced and certified simulations and computer programs [ICAO, 2020a].

In Poland, the publication, documentation and provision of all airport and operational procedures to users are the responsibility of the PANSA. These are published in the publicly available AIP – in this case, in Part 3 concerning airports. The published documentation must be provided in the English language and, optionally, in the local language used by the respective entity for communication in the airspace. For the sake of safety and standardisation, the charts issued should have a clear, similar layout and be commonly used, unambiguous, and internationally established designations. All publications are released in 28-day cycles (Aeronautical Information Regulation and Control, AIRAC), which ensures that the information provided is up-to-date. AIP users primarily include airlines that utilise it for flight planning and management, and provide either a paper or electronic version for aircraft crews. The data of the two subsequent AIRAC cycles are also uploaded to the aircraft flight management system. One of the conditions for their operational capability is access to a functioning, up-to-date navigation database.

Due to the nature of AIP publications in AIRAC cycles, the STAR and SID procedures do not exhibit the characteristics associated with traditional transport infrastructure (e.g., roads or railways), i.e., long implementation and operation periods. Their reliance on virtual navigation points allows them to be freely modified and adapted to the dynamically changing air transport market (theoretically every month). Day-to-day operations are one of the best indicators of quality fulfilment. All errors made in the design process and unnoticed during authorisation should be adjusted on an ongoing basis, especially when it is possible to implement changes quickly. For the SID and STAR procedures, changes should be indicated by incrementing the procedure name by one version digit (for the digit 9, the change is back to 1) and adding a brief note on what exactly has been adjusted.

Procedures based on ground-based navigation aids are much closer to those for the traditional transport infrastructure, For example, in all precision landing procedures, the location of antennas usually remains unchanged over the years, except when they are replaced with newer versions or when construction work is carried out. In this case, the validation and certification process should be carried out with particular care, as any change in the characteristics of the operation or the position of ground-based navigation aids entails costs and more extended interruptions in operation. The procedures proposed in this study constitute a preliminary framework based on regulatory guidelines and environmental constraints. However, their operational validity must be confirmed through comprehensive validation processes. Future work will include advanced flight simulation testing, safety assessments in accordance with ICAO Doc 9906 [ICAO, 2017], and consultations with ATC to ensure procedural feasibility in real-world scenarios. Particular emphasis will be placed on identifying risk factors such as airspace congestion, communication limitations, and unexpected obstacle interactions. These efforts will serve as a foundation for certification and publication in AIP Poland.

CONCLUSIONS

To summarise, the proposed structures of airport-related navigation procedures for the central transport hub are characterised by their versatility, susceptibility to modification, and adaptation to market needs (SID and STAR), an advanced certification process and a high safety standard. These features will undoubtedly help fulfil the mission of a modern, central air hub for Poland and Central and Eastern Europe. The implementation of this goal is primarily manifested through the adaptation of procedures to manage air traffic effectively at the future airport. In general, this paper determined four expected main traffic flows of aircraft to and from the CPK:

1) The north-west direction – transatlantic routes serving the United States and Canadian markets, as well as Scandinavia.
2) The south-west direction – intercontinental routes serving the Western European and South-Western European markets.
3) The south-east direction – intercontinental routes serving the Central European and Balkan Peninsula markets, and transcontinental routes serving the Turkish, Caucasian, Middle Eastern, Persian Gulf and Indian Peninsula markets.
4) The north-east market – intercontinental routes serving the East European, Finnish and the Baltic States' market, and transcontinental routes serving the Central Asian, Chinese, Korean and Japanese market. The prerequisite for its functioning is the open airspace of the Russian Federation, Belarus and Ukraine.

All of the above are in line with the current development strategy for the Warsaw Chopin Airport network connections (ICAO: EPWA), which also forms the basis for the CPK, as well as the development strategy for Poland's leading national carrier, LOT Polish Airlines.

In addition to the aspect of assistance in the implementation of the mission and development objectives of the CPK and LOT, the designated navigation procedure paths also help minimise the negative impact of air transport on the environment and the population living near the airport's operational area, while ensuring the efficient and, above all, safe flow of air traffic.

Finally, it is essential to note that navigation procedures can be extensively modified. This will enable them to be dynamically adapted to the changing environment and air transport market in the future, thereby achieving the unrestricted development and operation of the CPK itself.

Acknowledgments

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