Regional airport airspace redesign supported by GNSS and RNAV procedures

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Abstract. In recent years smaller regional European airports have been faced with an issue of maintaining the attractiveness in terms of availability during difficult weather conditions. Compliance with airport equipment for IFR flights of higher categories was the regional airport problematic in terms of economic accessibility until the recent past.
With the development of Global Navigation Satellite Systems (GNSS) arise new opportunities for regional airports to implement the Area navigation (RNAV) procedures without a necessity construction of terrestrial radio navigation equipment. The technical possibilities are at a level that is not a problem to lead a plane in the pre-defined vertical and horizontal trajectory.
The article also analyzes the current situation in this topic at the Kunovice airport. It outlines the possible options how to increase the availability and attractiveness of this, in conditions of the Czech Republic, specific airport.

Key words: Area Navigation, Global Navigation Satellite Systems, waypoint, final approach, vertical path angle, missed approach point

1 Introduction

The first stage of our effort was to create an outline of RNAV GNSS STAR for appropriate regional airport. This goal has been described in previous article presented in Žilina in April this year. The article, which you are reading now, is more focused on approaches and landing than on arrivals and builds on the STAR outline.

As it was mentioned in the previous articles, the development of global navigation systems and its satellite augmentation gives a good opportunity to regional airports in lower operational minima closing to the ICAO CAT I ones. There is a chance to reach the OCH (obstacle clearance height) value in some cases 250 ft. This is in comparison with the minimal OCH value of 350 ft for the NDB approach an obvious improvement. For completeness, for ILS and GBAS approach of CAT I is the OCH value 200 ft.

2 Kunovice airport – instrument arrivals and approaches

2.1 Current situation description

Kunovice airport (LKKU) is located about 4 kilometers to the south of the city Uherské Hradiště in the south-east Moravia. Its airspace is surrounded by Brno airport airspace on the west, Přerov

military airport on the north. Looking to the east and south direction there are Bratislava and Wien flight information regions (FIR).

From the ground to the altitude 5000 feet there is CTR (Control Zone) Kunovice situated. Above CTR Kunovice is TMA III Brno. The reason for this airspace organization is that no radar service is available at the LKKU. Radar control is provided from Brno Tower. Both, TMA III Brno and CTR Kunovice are airspace of the class D. The structure which was described above is illustrated on the Figure 1. More detailed information is available in the AIP of the Czech Republic [2].

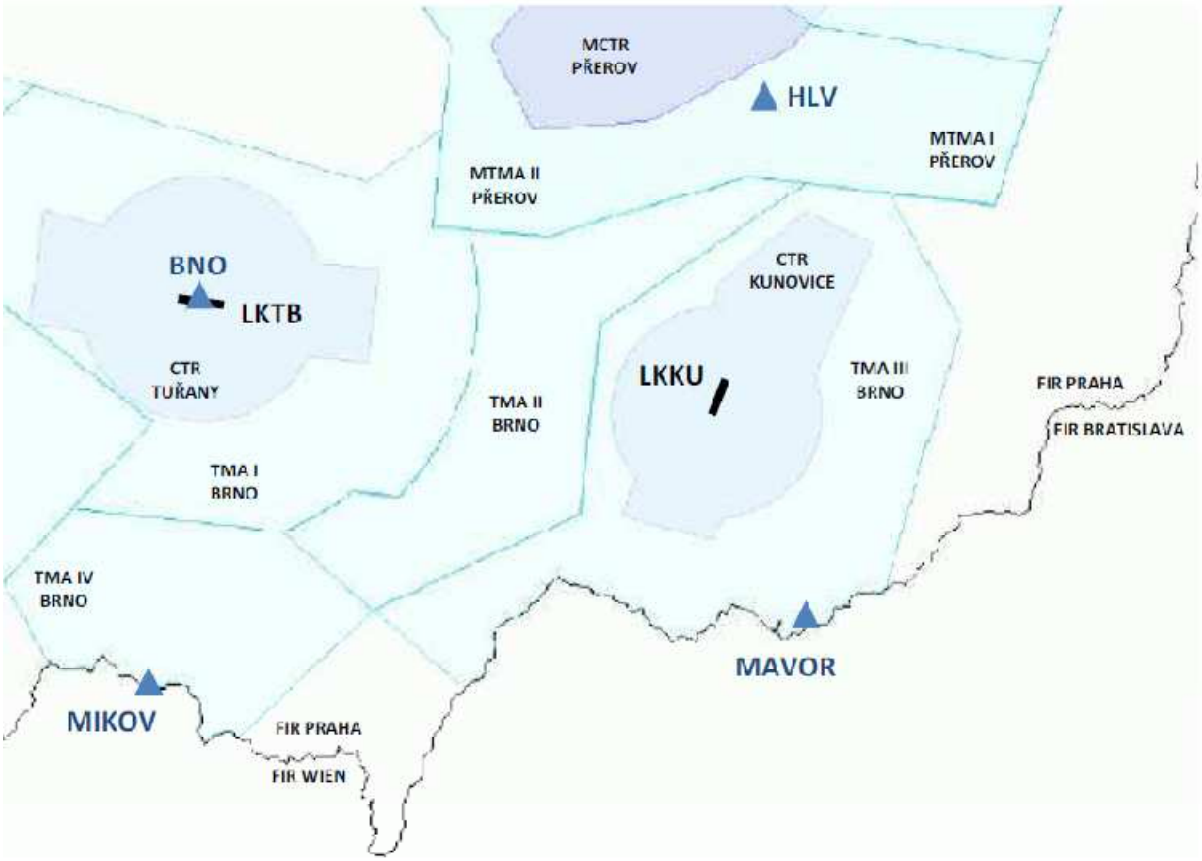

Figure 1: South – east Moravia airspace horizontal structure

Today, as mentioned in the previous article [1], non – RNAV STARs are available for runway 21C. There is not issued any instrument arrival and approach procedure for 03C. Arrivals are currently led from four entry points, MAVOR, HLV, BNO, and MIKOV. The points and its location is shown in the Figure 1**.** NDB/NDB procedure is used like an instrument approach for the runway 21C. First NDB KUN represents simultaneously the IAF and FAF. Second NDB KNE represents MAPt (Missed Approach Point) with OCH value 420 ft. All current arrivals are led to the IAF KUN. After flying over the IAF the aircraft begins the right base turn and descents to altitude 2500 ft at the same time. When the aircraft finishes the base turn and reaches FAF above KUN point it starts to descent in runway axis direction to the OCA/H. when reaching the second NDB KNE pilot passes the MAPt and he must decide for landing or for missing of the approach procedure in dependence on visual contact with runway or approach light system. The whole procedure is described in the IAC NDB 21C chart published in the AIP of the Czech Republic [2].

2.2 RNAV GNSS STAR 03C outline summary

The most challenging issue by the STARs to runway 03C construction was the horizontal solution for arrivals from reporting point (REP) MAVOR. Both, terrain profile and FIRs boundary line don't give a chance for direct arrival to runway 03C approach.

We have prepared two outline variations. The first variation (Variation 1) represents a simpler solution of STARs with minimum new waypoints, with one IAF (BZENE). It also provides the most

safe arrival solution from REP MAVOR. Although this variation doesn't provide the shortest distance between MAVOR and IAF, it gives a good opportunity for faster aircraft to descent safely to desired altitude. The philosophy of Variation 1 solution is based on one IAF placed in south – west direction from the LKKU. The arrival from MAVOR is constructed to KNE point which is placed on the runway 21C axis.

Second variation (Variation 2) has been considered with two IAFs placed on the both, west and east side of the runway axis. This solution was chosen because the arrival from MAVOR doesn't cross the runway axis in comparison with Variation 1. In addition it provides a shorter flight distance to IAF.

Although Variation 2 provides shorter distance and no necessity of crossing runway axis, the turns and waypoints and leg distances on the arrival from the MAVOR point is on the edge of safe passage especially for the aircraft category C. At the moment, we prefer the first variation. There is a possibility of radar vectoring for the slower aircraft direct from MAVOR. The issue with runway axis crossing could be solved by giving a higher altitude for arrivals. This should divide departures and arrivals on the KNE point. In addition the traffic volume at the LKKU allows holding the takeoff until the arriving aircraft flies over the KNE without any delay. The Variation 1 outline is sketched in the Figure 2.

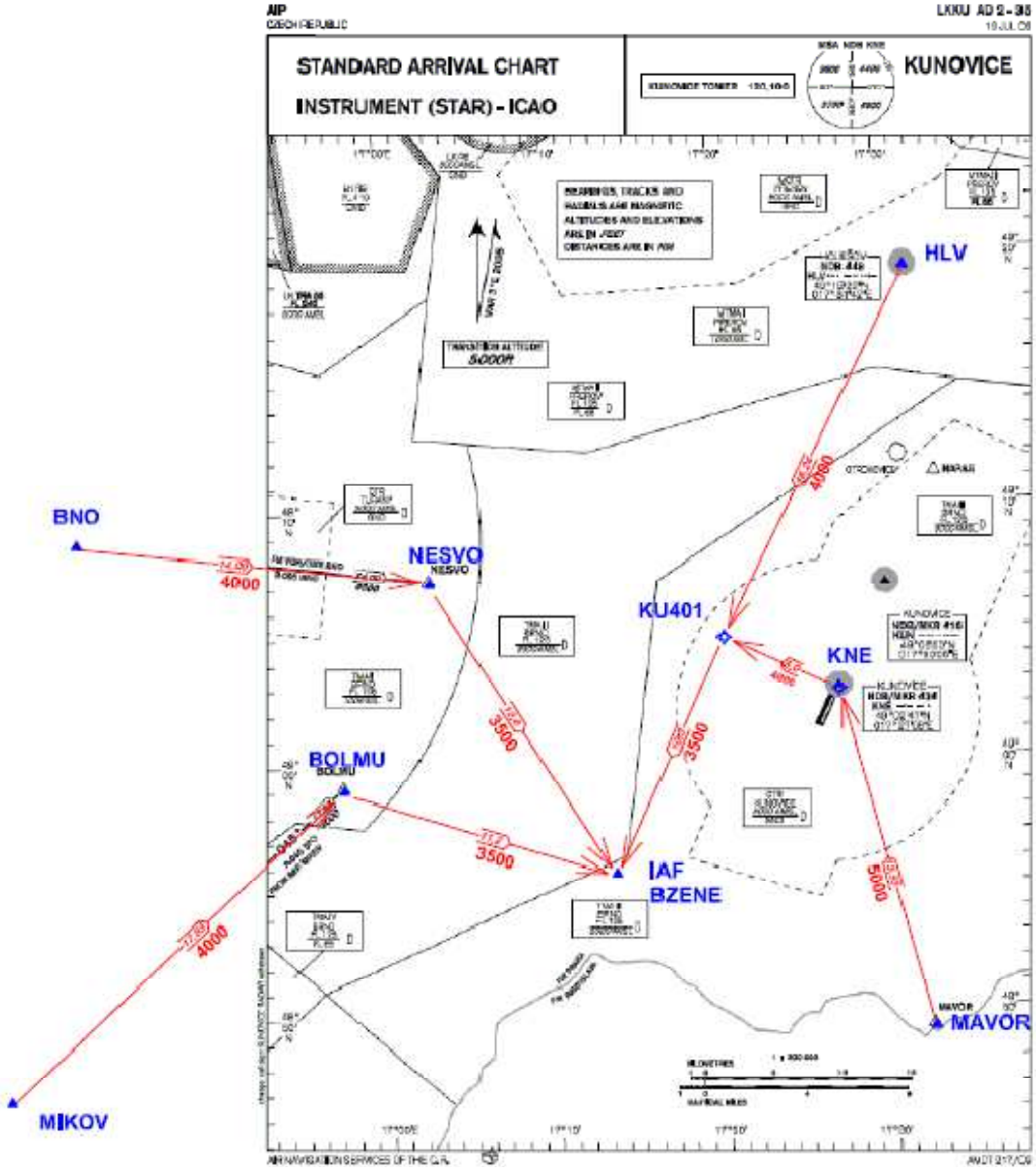

Figure 2: RNAV STAR outline - Variation 1

3 APV/SBAS approach to runway 03C LKKU outline

The approach design to runway 03C is based on arrival Variation 1 as it was described in previous text. The outline has primarily been considered as the APV (approach with vertical guidance) with the SBAS support. There is another APV called Baro VNAV, which means that vertical guidance is assured with baro – vertical onboard equipment. Usually, on the IAC (instrument approach chart) are three lines of OCA/H for each aircraft category. First LNAV is the OCA/H value for approach procedure only with longitudinal support of basic GNSS. Second line designated LNAV/VNAV represents APV – Baro, as mentioned above. The third line called LPV is the minima for APV – SBAS.

3.1 Approach horizontal shape determination

For maximal comfort by descent for the aircraft category C was determined IAF BZENE distances from the runway axis 5 NM. This distance is suitable also because of arrivals from the entry point HLV, which is far from the runway center line also 5 NM. This will mean that the flights from HLV to IAF will not need to change the direction of flight. The longitudinal distance from the runway threshold 03C is dependent on the distance from the FAF to the runway threshold and VPA, which was in accordance with the settings APAPI left to 3.5 °. The total distance between the IF and the FAF must be such that after turn over the IF remained at least 2 NM to FAF. The total calculated distance for the IF – FAF – 03C threshold is 8,63 NM. The entire horizontal shape of the runway 03C approach is in the Figure 3. In accordance with current procedures the minimum flight altitude after IAF BZENE was established to 2500 ft.

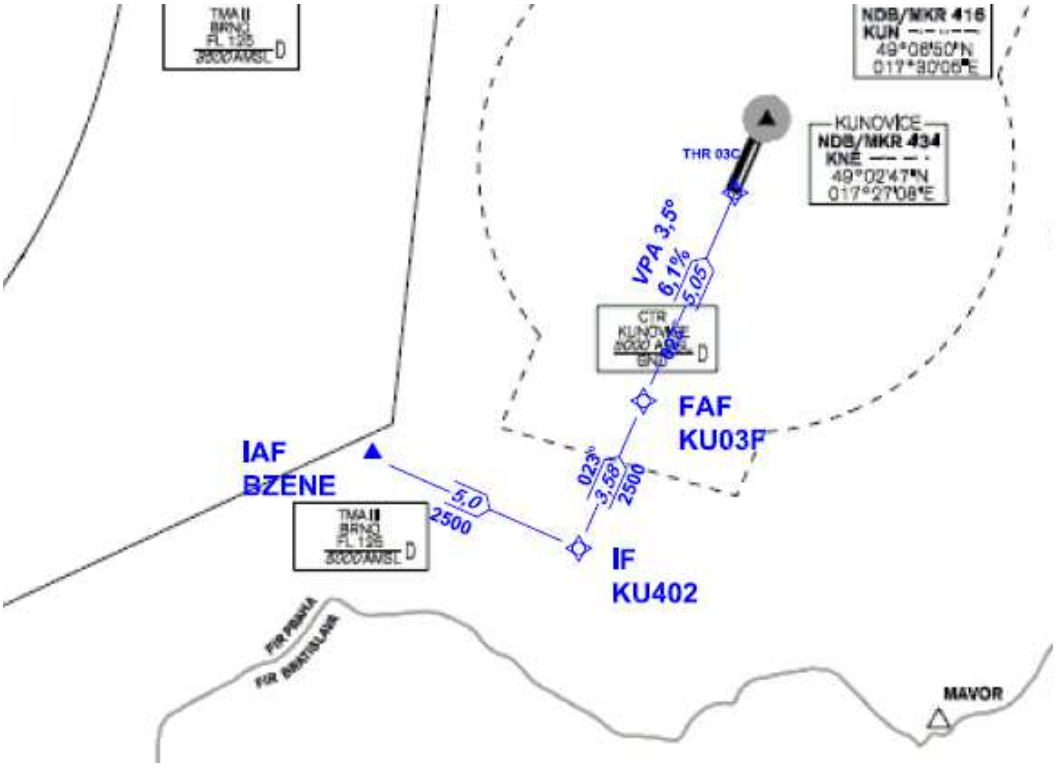

Figure 3: Horizontal shape of 03C runway APV approach

3.2 OCA/H calculation

At the moment the horizontal shape of approach, distances and minimum flight altitudes for approach legs are known. We are looking for the important value which is called the OCA/H value. It is affected by following factors:

- Vertical path angle (VPA)
- Critical obstacles altitudes/heights
- FAF (FAP) altitude and distance from IF
- Missed approach segment appearance
    - API slope
    - Turning Point (TP) – threshold (LTP) distance

For the OCA/H calculation was used the special software called MET (Minima Estimation Toll) developed by Eurocontrol for final approach design purposes. Before the compute run will be started, MET requires entry parameters which are shown in the Figure 4.

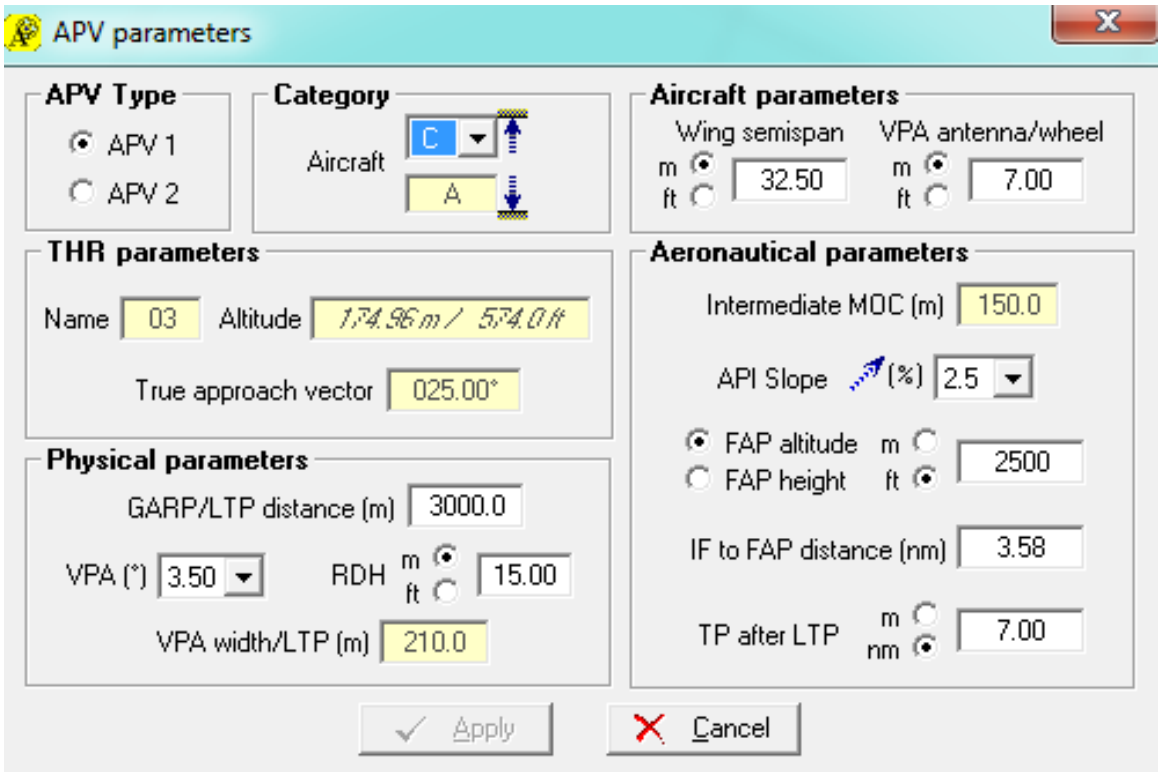

Figure 4: MET entry parameters for APV

As well as setup parameters, MET requires a list of all possible obstacles that could affect OCA/H. It is shown in the Figure 5. Obstacle LTP with reference number 000 means the Landing Threshold Point. To simplify are specified only two most important obstacles. As more obstacles is listed you will get a more precious result.

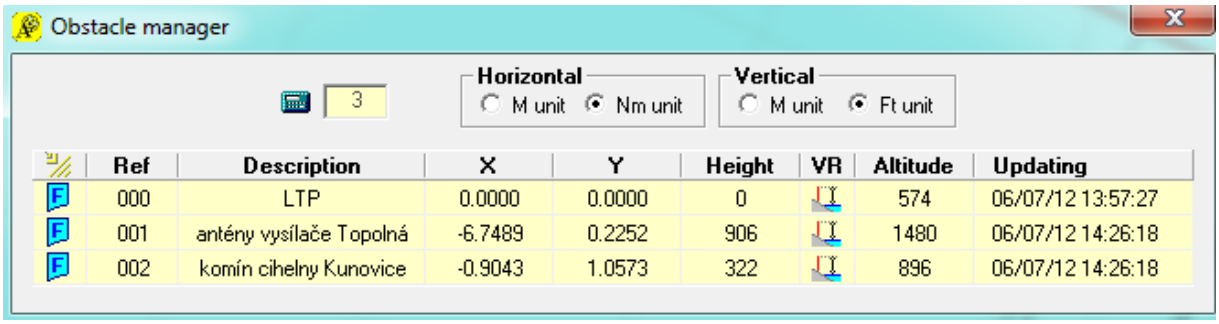

Figure 5: MET obstacle manager

Now, MET is ready to compute results. It´s important to note that MET doesn't have implemented any limits on the values of OCH in relation to type of approach. For APV – SBAS approaches is the minimum value given by the EU OPS 1 regulation to 250 ft and where is no appropriate runway equipment the value there is 300 ft. The table in the Figure 6 shows resulted OCA/Hs below the limits of 250 or 300 ft. In this case of not equipped runway 03C with the lighting system for CAT I, we consider OCH for each aircraft category 300 ft.

The result list in the Figure 6 shows in the first line the most significant obstacle. In our case it is obstacle 001 the Transmitter Topolná. Figure 7 gives us an obvious information that obstacle 001 is under the APV surface whereas obstacle 002 is out of the APV surface horizontal footprint. The question if the critical obstacle penetrates the surface or not is answered by MET in the results list. MET also enables an vertical profile view where you can check the approach from the side view.

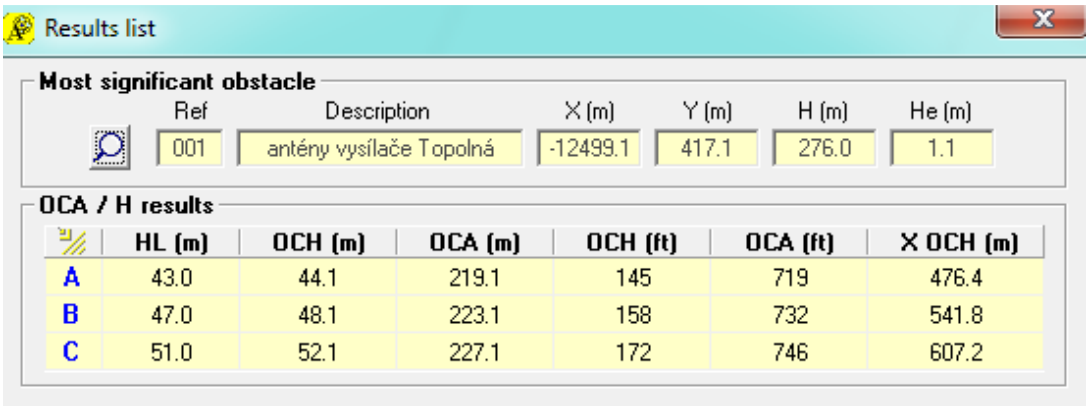

Figure 6: MET results list

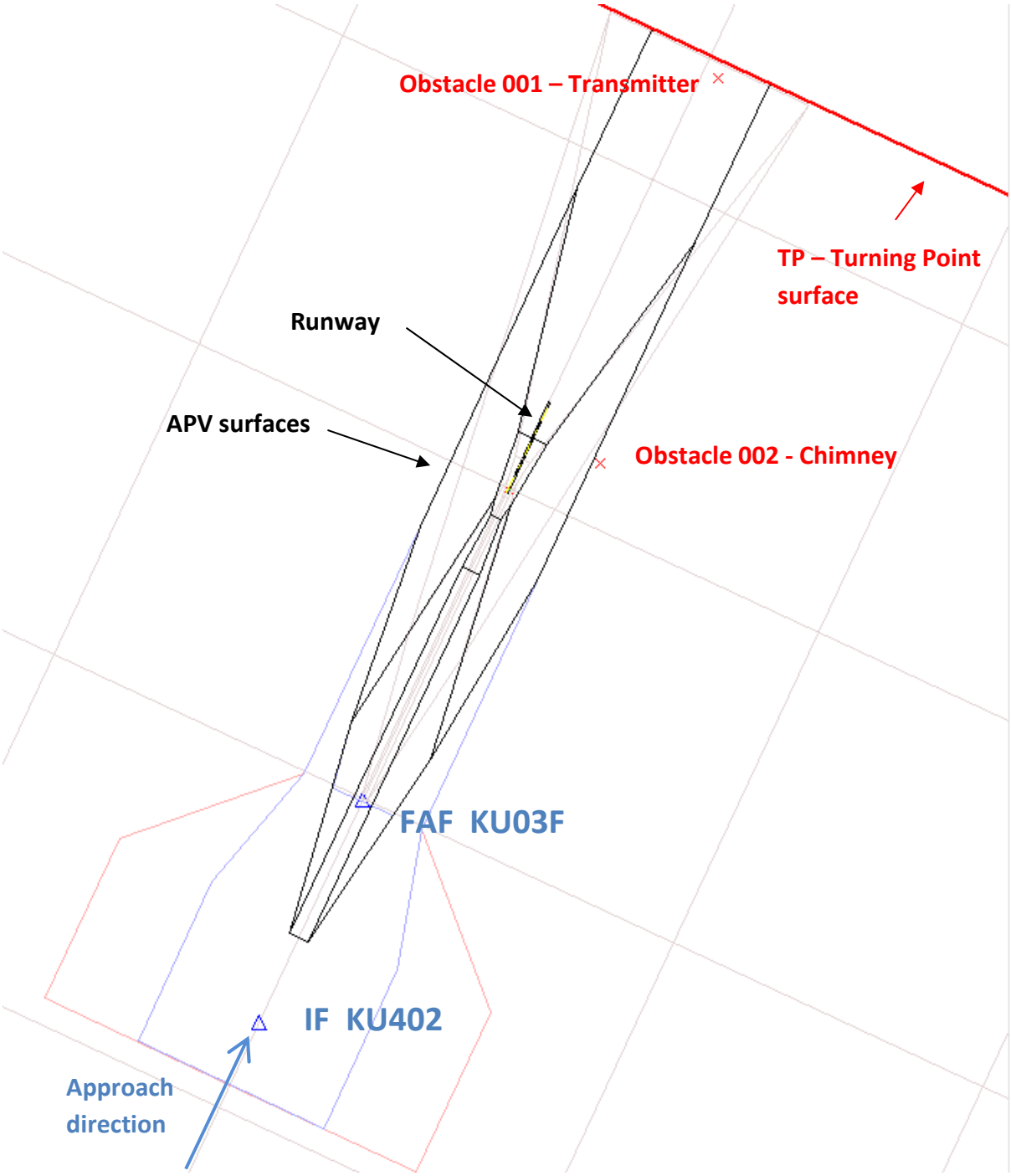

Figure 7: Horizontal shape of APV approach shown in MET

4 Conclusion

The article aims to outline the progress in the reorganization of the LKKU airspace. It provides a simplified view of the process of designing standard instrument arrivals and phases of instrumental landing approach with vertical guidance with SBAS support.

When compared with current NDB/NDB non precision approach (NPA), we got OCH 120 ft lower value, which is almost 40 meters. In the case of equipping the runway 03 C with a approach lighting system for ICAO CAT I, the OCH value would decrease to 250 ft, which makes difference more than 50 meters in comparison to current situation.

The next stage of our effort will be redesign of the rest of procedures to RNAV ones. Intention of the last step will be the validation of designed procedures by using simulation software Visual SIMMOD.

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