ANALYSIS OF LANDING IN IMC AT VFR AERODROMES

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Summary. This paper is about summarizing the possibilities of landing in IMC at VFR aerodromes. The main point of this article is to provide a complex view on possibilities of landing in IMC and analyse the most suitable approach procedure for VFR aerodromes.

Keywords: RNP approach; APV; landing in IMC; VFR aerodromes

1. INTRODUCTION

Nowadays, VFR aerodromes are relying on favorable meteorological conditions defined as VMC. However if the conditions are worse aerodromes are closed and all traffic is grounded or diverted to another aerodromes. This significantly reduces the usage of VFR aerodromes particularly during autumn and springtime when inversion occurs. The main point of this article is to find the most suitable approach procedure for landing in IMC at VFR aerodromes. This procedure could increase the usage of aerodromes what could bring greater income and development of services provided there.

2. VFR AERODROMES IN THE CZECH REPUBLIC

In the Czech Republic are currently 92 aerodromes from which eight are capable also for IFR traffic. It means that 84 aerodromes can be used only in VMC. These aerodromes have different physical characteristics but the most important part is runway. Runway can be paved or unpaved with different lengths for run, take-off or landing and with different lighting. Figure 1 shows the percentage representation of landing distance available at Czech VFR aerodromes. Green colours represent unpaved-grass aerodromes and dark shades represent paved runways. As we can see, 10% of all VFR aerodromes are equipped with paved runway with length at least 1000m. Moreover 48% of grass runways are longer then 1000m what gives nearly 60 % of all VFR aerodromes are equipped with long enough runways for instrument approach.

However the only 3 aerodromes are equipped with at least some lighting equipment.

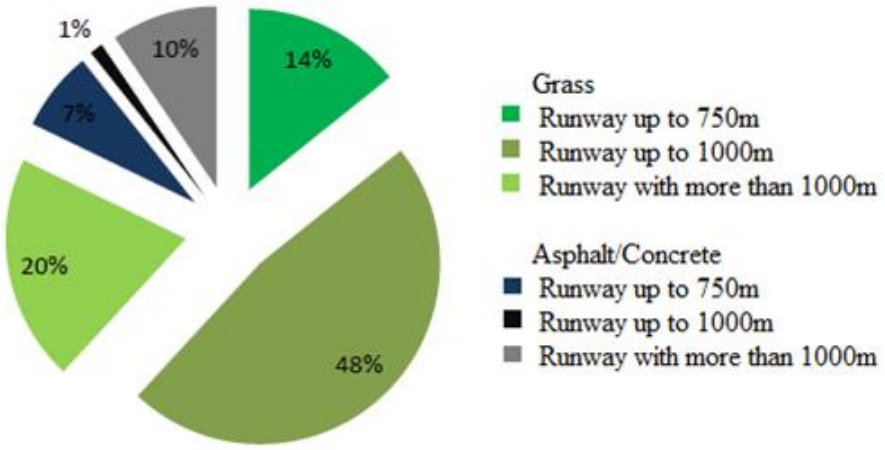

Figure 1 Distribution of Czech aerodromes LDA

3. APPROACH PROCEDURES

When meteorological conditions are worse than VMC it is called instrument meteorological conditions. In IMC it is more difficult to recognize a runway so certain approaches decision height (DH) and runway visual range (RVR) is stated. Basically, there are three approach types:

- Precision approach
- Non precision approach
- Approach with vertical guidance

The precision approach is a procedure where both vertical and lateral guidance is provided. Nowadays there are 4 different precision approaches, ILS, MLS, GLS and PAR. However, ILS is the most widely used type and also the only one used in the Czech Republic. In ILS, lateral guidance is controlled by localizer, vertical guidance by glide path. Distance is measured by DME. This system provides the best accuracy but also costs for installation and maintenance are high. As it is shown in figure 2, there are many elements to be installed for implementing the ILS. The approximate costs of ILS CAT I installation is about 336 000 euro with annual maintenance cost around 80 000 euro. [1]

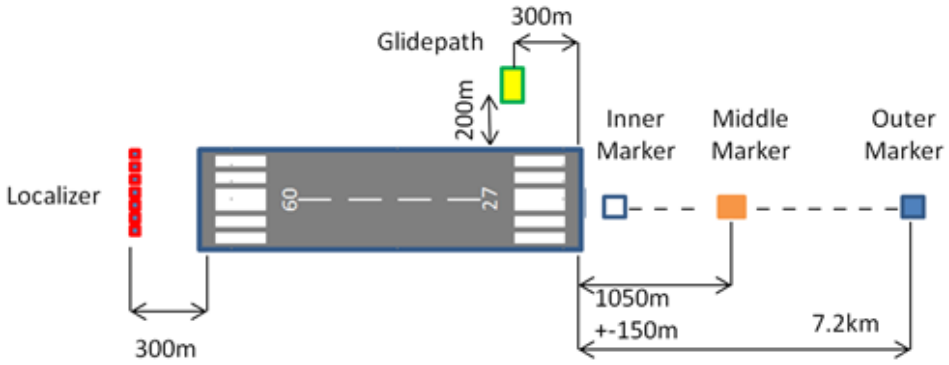

Figure 2 ILS installation

The second type is a non-precision approach. This type is used where there is not so important to land in any meteorological conditions. In comparison to the precision approach, non-precision approach doesn't provide the vertical guidance that is why DA and RVR are moved to higher numbers. For non-precision approach the conventional navigation facilities like VOR, DME, NDB, localizer, VDF, SRA or combination of these are used. However, like ILS system these systems must also be constructed and maintained during the year what consumes significant amount of money what small VFR aerodromes don't have.

The last one method of approach is the newest one and it is based on GNSS principles. The approach with vertical guidance is in fact the non-precision approach however the accuracy provided is similar to ILS CAT I. Approaches with vertical guidance are RNP APCH down to LNAV/VNAV or LPV minima. All RNP approaches are shown on figure 3.

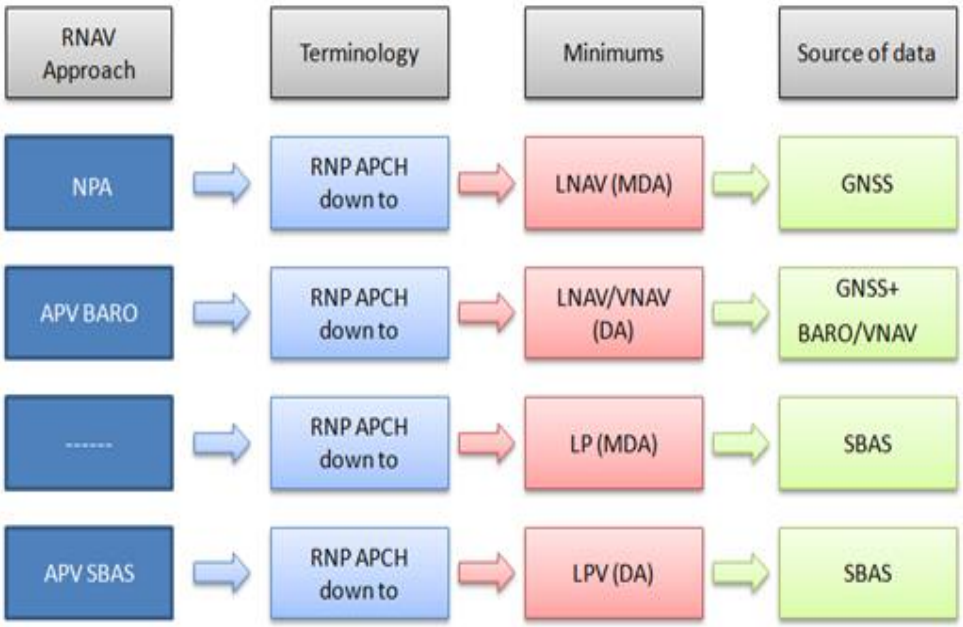

Figure 3 RNP approaches [2]

As it is said in figure 3, the source of data of RNP approaches is from GNSS. This gives aerodromes huge advantage because this type of approach does not need any ground facilities like precision or conventional non-precision approach. It means that an aerodrome doesn't need to spend extra money for some ground facility. It opens a new opportunities to those aerodromes which are willing to find a compromise between the regulations and self-investments for implementation of IFR traffic.

The table 1 shows a comparison of instrument runways in the Czech Republic with all RVR and DA for non-precision and APV approaches. As it can be seen, the APV approach reaches better values for both parameters so it can be said that APV approach is the most suitable approach for VFR aerodromes in IMC conditions. These information are provided from a Jeppesen database.

Table 1 Minima of non-precision and APV approach [3]

Aerodrome	Runway	Approach type	DA/DH	RVR
LKTB	28	LPV	250ft	750m
		LNAV/VNAV	296ft	750m
		VOR/NDB	396ft	750m
	10	LPV	300ft	900m
		LNAV/VNAV	300ft	900m
		VOR-NDB	396ft	1400m
LKKV	29	LPV	201ft	750m
		NDB	581ft	2000m
	11	LPV	361ft	1500m
		LNAV/VNAV	463ft	1500m
		NDB	481ft	1500m
LKKU	21	NDB	419ft	1500m

LKMT	22	LPV	262ft	750m
		LNAV/VNAV	292ft	750m
		VOR-NDB	362ft	1000m
	04	LPV	296ft	900m
		LNAV/VNAV	296ft	900m
		VOR-NDB	376ft	1300m
LKPD	27	NDB/DME	438ft	1300m
		NDB	458ft	1300m
LKVO	28	LNAV/VNAV	315ft	1000m
		NDB	365ft	1300m
	10	LNAV/VNAV	340ft	1500m
		NDB	340ft	1500m
LKPR	06	LNAV/VNAV	398ft	1400m
		NDB	398ft	1400m
	12	LNAV/VNAV	330ft	1100m
		VOR	370ft	1300m
	24	LNAV/VNAV	302ft	750m
		NDB	302ft	750m
	30	LNAV/VNAV	298ft	750m
		VOR	398ft	1100m

The table 1 shows significant differences in DA/DH between LPV and NPA minimums. All APV procedures give at least the same or lower minimums than NPA procedures. LPV gives a DH in the case of a 33.5% lower than NPA. Also LNAV/VNAV approach type provides better guidance by 13% than conventional non-precision approach (NPA).

This analysis clearly demonstrates that APV technique offers at least the same performance as non-precision approach without any ground facilities.

4. THE ADVANTAGES OF USAGE OF RNP APCH FOR VFR AERODROMES

First advantage for general aviation is increase of aerodromes capable to provide IFR approach. Today only big airports can be used for IFR flights. However with the implementation of APV procedures at VFR aerodromes the number of backup aerodromes will increase significantly what will positively increase the level of safety of general aviation.

The other advantage is for aerodromes operators. Training for instrument rating is divided into two parts. The first one is made on a simulator. The other one is made in the airplane. This part of the training must be done at IFR airports because of drilling instrument procedures. It means that pilot has to fly from home airfield to one of the big IFR airports and exercise specified tasks. This flight between home and big aerodromes consumes some fuel and time. This of course costs money of pilot-students. Also navigation and landing fees must be paid for services provided at IFR airports.

All this costs could be saved by implementing the APV approaches at VFR aerodromes. Some or all of training parts could stay at home (VFR) aerodrome. This brings more income for aerodrome operators, what could positively affect level of service provided to customers. Also it saves funds of customers what can bring more pilot-students into training programs.

The APV approach is part of RNP, which allows to guide the airplanes throw the airspace by specific prescribed route. This allows prescribing a specific approach path where all arriving or departing airplanes will avoid towns and villages in vicinity of aerodromes. Nowadays, departing and arriving information are published in the AIP. But, even if pilots trying to fly according to this recommendation lots of them overfly surrounding residential areas what irritates people living in vicinity of the aerodromes.

With usage of RNP approach pilot will select the approach path for aerodrome in the GNSS equipment. The path will display in navigational panel and pilot will just follow the prescribed line.

This can be also used in VFR flights as additional navigational help. The implementation of APV approach can positively affect relations between residents and aerodrome users thanks to reducing the noise emissions.

5. IMPLEMENATATION OF APV APPROACH AT VFR AERODROMES

For implementation of this procedure aerodromes have to make some changes. Because of approach in conditions lower than VMC, aerodromes should be equipped with threshold and runway end lights as well as runway edge lights. For better orientation there should be also PAPI or simple approach lightning system.

It is very important to serve actual meteorological conditions to the pilots so aerodrome should be equipped with information service. Information likes wind speed and direction, cloud base, temperature, RVR should be continuously provided during operation of the aerodrome.

For APV approach there must be published procedures like initial, intermediate and final approach segment as well as missed approach procedure. Also decision height or altitude must be stated. For LPV approach FAS Data Block must be published. All procedures and information related to procedures like maps must be published in the AIP.

For this type of approach, airplane must be equipped with equipment, which allows satellite guidance. All criteria for airplane equipment are written in PBN manual. Basically it is necessary that equipment is capable to receive the SBAS correction (for LPV). Usually these devices are highly sophisticated GNSS receivers however lots of new small general aviation airplanes have been already equipped. The table II provides a list of selected devices that allows necessary functions.

Table 2 GNSS with SBAS support [4]

Manufacturer	**Type**
Garmin	G 1000
	G 600
	G 900 X
	GNS 530 W
	GNS 430 W
Honeywell Bendix King	AV80R range
	KSN 770
	EASy II
	Pirmus Apex
	KI 825
Rockwell Collins	GPS 4000 S

Pilot training should be changed for APV approaches. Nowadays are pilots trained for ILS approaches, what is great. But for non-precision approach are pilots trained for VOR or NDB approaches what needs to be changed. The conventional old navigation equipment will be replaced with new approach types. It is necessary to modify pilot training programs and adapt it to new trends in aviation.

6. REGULATION CHANGES FOR IMPLEMENTATION OF LANDING IN IMC AT VFR AERODROMES

The implementation of APV procedure at VFR aerodromes requires complex changes what affects many levels of aviation rules and regulations. It is very important to define which VFR airfield may implement APV procedures and what they have to do for this change. This directly affects national regulation L14. Also in the directive L8168 has to be specified approach with vertical guidance at VFR aerodromes.

As it was mentioned the regulations about pilot training should be changed and bigger emphasis should be on cooperation with GNSS equipment. This includes standard, abnormal procedures and identifying displayed information as well as critical signs of loss of integrity.

There is also other regulation that could be discussed as:

- L6 Aircraft operation where is necessary to establish minimum equipment list for general aviation aircraft to make approach with vertical guidance at VFR aerodrome
- L4 Aviation charts where is necessary to described how to publish the approach charts of VFR aerodromes
- L4444, L15, L10 are also related to this issue.

7. CONCLUSION

The approach with vertical guidance supported by SBAS technology is one of the biggest steps what commercial aviation did in last decades. Low costs of operation and very high level of precision in both lateral and vertical guidance makes this technology the most suitable for implementation at VFR aerodromes. This could positively affect a level of aviation safety by creating many backup aerodromes for IFR traffic. It also creates new possibilities for training organization and for aerodrome operators. Set up of RNP APCH at VFR aerodromes will have a positive impact at surrounding areas and villages in vicinity of aerodromes. Specific and predefined track will guide aircraft out of residential areas what reduces noise emissions.

It is necessary to realize what a potential the RNP APCH brings. In the Czech Republic is 10 times more VFR aerodromes then IFR. It opens a new hidden segment of transportation. This fact should be taken into consideration of local but also national authorities and by wide aviation public. By setting an optimal financing of VFR aerodromes, the Czech Republic could create a new segment - aero tourism.

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