

## MANAGEMENT OF AIRSPACE CAPACITY AROUND UNCONTROLLED AERODROMES

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*Summary: This article focuses at heavy traffic at uncontrolled aerodromes, which is not dealt with and at the resulting critical situations of it and also with the appropriateness of implementing capacity management in aerodrome traffic zones to increase safety of General Aviation. This paper shows a model for this capacity management and solution for related issues.*

*Key words: AFIS, AFIS Officer, ATZ, ADS-B, Workload*

### INTRODUCTION

Flight operations in the Czech Republic will undergo a major change this year; the classification of aerodromes would change. Until now, there were two types of aerodromes. The first one was controlled airport and the other one uncontrolled aerodrome, where the AFIS service was provided. These types also corresponded to the assignment of rules of the air, thus IFR and VFR in all contexts.

New category of aerodromes will be created by splitting the uncontrolled ones by the end of 2014. The current conditions for AFIS aerodrome will be equal with aerodrome with information service about the surrounding traffic and the designation AFIS aerodrome will be assigned to new type with stricter conditions for providing aerodrome flight information service, e.g. with mandatory certification.

Due to the large differences between the existing categories of controlled airport and AFIS aerodrome will be basically created an intermediate one with provision of quality information service, which would be a good step for the subsequent improvement of aerodromes at a reasonable cost. Although introduction of requirements for "new" AFIS is not anticipated for somehow specified aerodromes, it would be a good choice for improving safety at uncontrolled aerodromes with heavy traffic.

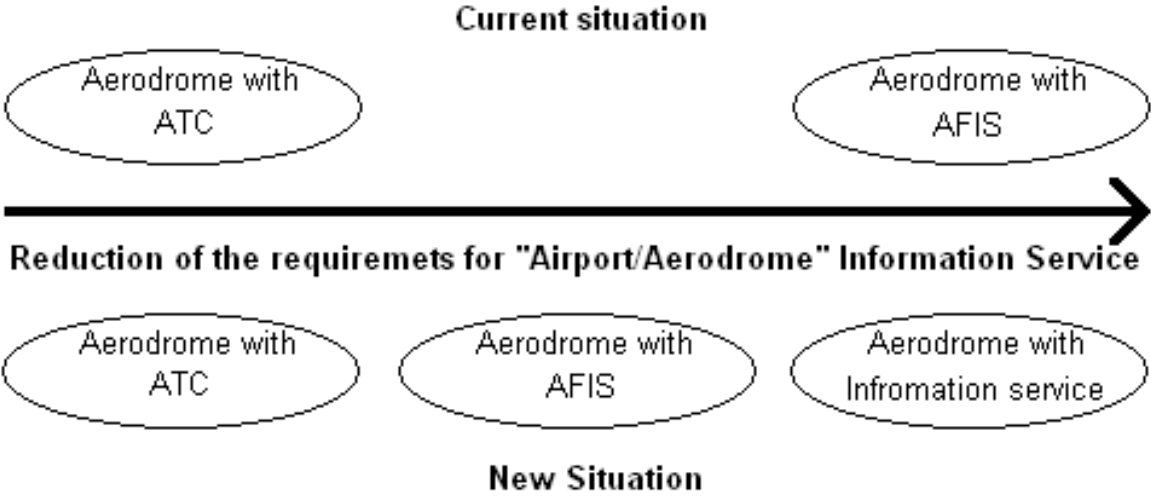
This is yet another issue which changed regulation do not handle. There is the possibility of overflow AFIS officer and the resulting errors in providing the information about the surrounding traffic. When flying VFR, the responsibility for spatial awareness and maintaining separations between aircraft still remains at the pilot, but if there are more than twenty aircraft in aerodrome vicinity, the accurate information from AFIS officer is very helpful.

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Due to all these reasons, there is room for a system to manage the maximum number of aircraft in areas like ATZs - around uncontrolled aerodromes.

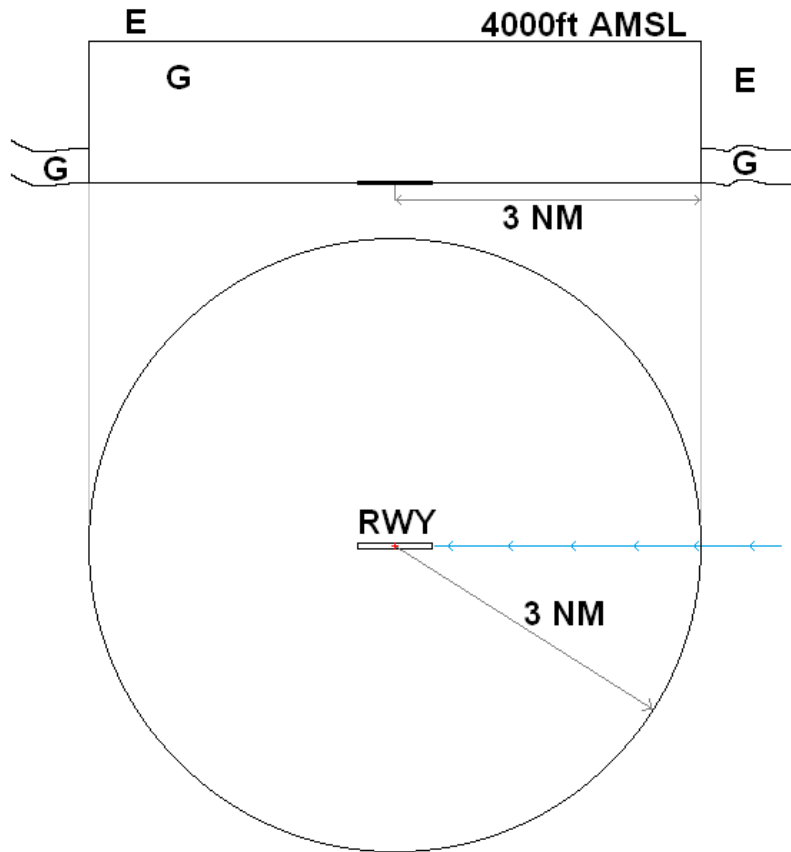


Source: (Authors)

Fig.1 – Position of the “new” AFIS

**1. UNCONTROLLED AERODROME AND ATZ**

Uncontrolled aerodrome is one, where air traffic control service is not provided and instead of it is provided only aerodrome flight information service, or in future information service about the surrounding traffic. Around all uncontrolled aerodromes in the Czech Republic is established airspace called ATZ, i.e. aerodrome traffic zone, which has a cylindrical shape with a radius of 3 NM from the aerodrome reference point and a height of 4000 feet above sea level (1). This airspace is classified as class G and therefore aircraft flying under Instrument Flight Rules could not enter into ATZ.



Source: (Authors)

Fig.2 – Aerodrome Traffic Zone

### 1.1 AFISO vs. ATCO

Heavy traffic in the ATZ would not “go away” with the professionalization of AFIS, which arises out of the mandatory certification. This situation can be compared with the air traffic control service. In both cases the pilots in the airport/aerodrome area communicates with the air traffic controller (ATCO)/AFIS officer (AFISO) on the ground and asks information, but the workload is different. Air traffic controller has technology for tracking aircraft, and thus knows at all the time where machines under his “command” are. AFIS officer’s situation is different, because he has only information passed to him over the radio. This shortage should be balanced by essentially zero responsibility for maintaining separation between aircraft. Therefore, from this perspective, the workload of AFISO and ATCO will be the same.

Unfortunately, there is one major difference that discriminates uncontrolled aerodrome with AFIS. The number of flights in the vicinity of controlled airports is limited by separations between aircrafts when flying on the track. So, the maximum number of aircraft for one controller is limited. The AFIS aerodromes and VFR traffic is nothing like this, which means a possibility of a greater workload.

Tab. 1 – Comparison of aerodromes in Czech Republic

Type of aerodrome	Number of AD in CR (3)	Maximal number of aircraft „controlled“ by one controller/AFIS officer
Controlled	8	Up to 7
AFIS	84	Up to 22

Source: (Authors)

## 1.2 The need for change

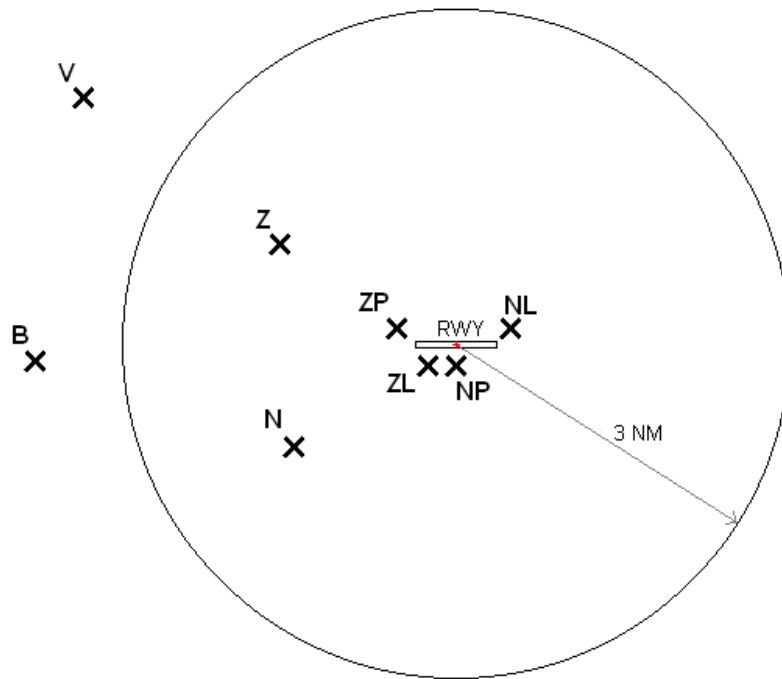
From the point of view of several times higher number of aircraft under one officer's "control" is convenient to manage the maximum number of aircraft in the vicinity of the aerodrome. This argument is joined with certain growth in the category of General Aviation, which will increase the number of aircrafts. One solution used in air traffic control service, which is a division of airspace into several parts and increase the number of controllers, is in small aviation unusable due to uncontrolled operation.

However, it would be possible to take advantage of holding procedures, which are used in large aviation during traffic overflow in terminal area, in times of weather conditions deterioration and low visibility operation (LVO), because exactly this situation occurs around uncontrolled aerodromes – traffic overflow.

## 2. OPTIONS FOR CONTROL

As mentioned above, the control of the maximum aircrafts number in the aerodrome traffic zone is a good option to reduce the workload of AFIS officer. Of course, the system must work automatically that the reduction in workload caused by limiting the number of aircraft under AFISO "control" was not replaced by operation with new system.

Currently it is possible to have aircrafts equipped with different avionics, because for VFR flying is basically needed only radio. From this condition come various categories of aircrafts, which are necessary to include into considerations. These categories can be derived from the type of communication equipment on-board, when for basic control is needed at least one aircraft with avionics, which will give the opportunity for control. The on-board avionics development is very strong today and therefore can be expected that the main system for air to air and air to ground communication will be ADS-B.



Source: (Authors)

Fig.3 – Traffic definition in ATZ

Aircraft's definitions:

- V...aircrafts outside the ATZ, we know about them, we can prohibit flight into ATZ
- B...aircrafts outside the ATZ, we don't know about them, we cannot prohibit flight into ATZ
- Z...aircrafts in the ATZ – transformed group V
- N...aircrafts in the ATZ – transformed group B
- A...aircrafts in the ATZ, without communication
- ZL...aircrafts ready for take-off, have the system, automatic prohibition
- NL...aircrafts ready for take-off, don't have the system, manual prohibition
- ZP...aircrafts on landing – category Z
- NP...aircrafts on landing – category N

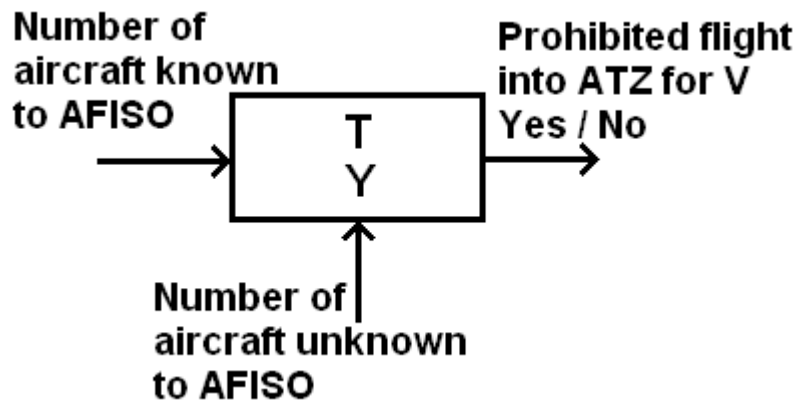
## 2.1 Model

The principle of this model is to prevent flying into airspace by passing prohibition for aircrafts located around ATZ which are known to system.

Assumptions:

- All aircrafts in the vicinity of ATZ want to enter into ATZ.
- Only some aircrafts have adequate equipment for reception the no-fly signal.
- There is possible to control the number of take-offs from the aerodrome
  - Some of the aircrafts automatically
  - Others manually – by AFISO command
- There is some, albeit small number of not communicating aircrafts, which are located in the ATZ

The basic model is here:



Source: (Authors)

Fig.4 – Basic Model

From the responses of AFIS officers is clear that trained officer, who has several years of experience, considers as reasonable maximum 20 aircrafts. This value will therefore be used as a maximum. When dealing with unexpected events there is needed more time and therefore this situation would not left enough time for other normal communication. For this reason, transmitting time is used as the second limit, for which will be considered value of 80%. And therefore:

Tab. 1 – Truth table for the model

Transmitting rate T (%)	Number of aircrafts in airspace Y	Fly into and take-off prohibition (Yes/No)
< 80	< 20	No
< 80	≥ 20	Yes
≥ 80	< 20	Yes
≥ 80	≥ 20	Yes

Source: (Authors)

## 2.2 Model's equations

$$Z_0 + N_0 = Y_0 \quad (1)$$

For each aircraft is needed 4% of the transmitting time, then  $Y * 4\% = T$ , and with  $Y = 20$  is  $T = 80\%$ , but in the airspace are also aircrafts without communication. Therefore  $Y_0 = Z_0 + N_0 + A_0 \sim 20$  and  $A \sim 10\%$  of traffic, which is  $10\% * (Z + N)$ . This increase the transmitting rate T of about  $A * (Z + N) * 0,2\%$ , because it is necessary to mention the non-communicating aircraft to each aircraft.

For  $t = 0$

$$T_0 = Z_0 * 4 + N_0 * 4 + A_0 * [0,2 * (Z_0 + N_0)] \text{ and it must be } < 80 \quad (2)$$

$$\text{and also } Z_0 + N_0 + A_0 < 20 \quad (3)$$

when  $Z = ZD + ZX + ZP, N = ND + NX + NP$ , ZD...aircrafts on departure out of ATZ, ND...aircrafts on departure out of ATZ, ZP... aircraft on landing, NP... aircraft on landing

For  $t = 1$

$$\text{IF prohibition} = \text{YES then } Y_1 = Z_0 + N_0 + A_0 - ND_0 - ZD_0 + B_0 - ZP_0 - NP_0 \quad (4)$$

$$\text{IF prohibition} = \text{NO then } Y_1 = Z_0 + N_0 + A_0 - ND_0 - ZD_0 + B_0 + V_0 - ZP_0 - NP_0 + NL_0 + ZL_0 \quad (5)$$

$$T_1 = T_0 + (B_0 + V_0 - ND_0 - ZD_0 - ZP_0 - ZD_0 + NL_0 + ZL_0) * 4 \quad (6)$$

### 2.3 Known Issues

The presented model has four issues that need to be mentioned.

The first issue relates to the conditions of the model  $T < 80\%$  and  $Y < 20$ , which are interchangeable, when considering the coefficient of 4% (qualified estimate from monitoring LKPM AFIS) transmitting rate for communication with one aircraft. It is therefore possible to deal only with one condition.

The second issue partially follows the first one and concerns the coefficients. This model is based on data out of LKPM analysis and it is therefore possible that it would be appropriate to modify the coefficients when applied to other aerodromes, although for experienced AFISO should be 4% sufficient.

Another issue relates to avionics of the aircrafts, which flies on General Aviation aerodromes. Most of these aircraft are equipped with only the necessary communication avionics, which is radio. For this reason, the aircraft group V is today significantly smaller than control group B and the capacity management will have limited effectiveness. Added to this is AFISO limited influence that he may give commands and prohibitions only in emergency situations to prevent an incident or accident, in which does not belong prohibiting the take-off (for Group NL) due to heavy traffic in ATZ.

The last issue is the outcome of capacity management, which will penalize aircraft equipped with appropriate avionics (ADS-B). It should be noted that this penalization will be only within minutes, which should be acceptable and would gradually disappeared with the equipping more aircraft with ADS-B. This should be and will be mandated by European Commission.

### 3. INTRODUCTION OUTCOMES OF CAPACITY MANAGEMENT

The introduction of airspace management described above would have excellent effects for aviation in transforming its perception. The current division of IFR – controlled and VFR – uncontrolled does not provide the sufficient space for development in the future. The perception of these two categories is quite different, because IFR category has rules for the safety of flying in zero visibility and VFR category is basically without rules. Yet "something in between" would allow the room for development. Also the proposed procedure could be applied to any part of the airspace.

In the beginning of the capacity management, the prohibition could be applied similarly as a temporary restricted area (TRA), so there would be prohibition, which is supported in legislation. One change would be required on the behalf of aircrafts already in ATZ, for which the “TRA” could not apply, as well as for aircraft not equipped with the necessary communication technology.

## CONCLUSION

In this paper, we propose a model of management of airspace capacity for uncontrolled aerodromes. This model could limit the maximum number of aircraft which communicates with AFIS controller, thus reducing his workload and therefore increasing safety. The model has four known shortcomings, some of which can be eliminated by adjusting the model directly to the aerodrome, where it will be implemented and where is necessary to perform a statistical analysis of the air traffic. The other ones will disappear with time.

The result of the introduction of such procedures will not only change one small aerodrome, but it can be impulse to alter the view of aviation IFR vs. VFR. This capacity management will have a clear benefit to safety and also may be an intermediate step to introduction of surveillance system for AFIS.

## ACKNOWLEDGEMENT

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