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ANALYSIS OF REGULATIONS CONCERNING IFR FLIGHTS OF RPAS UNMANNED SYSTEMS IN CONTROLLED AIRSPACE

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Summary: Aerial vehicles class of RPAS (Remotely Piloted Aircraft Systems) is group of unmanned flying vehicles performing non-autonomous flights, controlled by ground operator. Civil market of RPAS applications is dynamically growing part of industry. European strategy establishes to create the environment for performing RPAS civil operations in common airspace (by the 2024-2028 years). Currently, in Europe, the dominant model for RPAS flights is airspace segregation. The aim of this paper is the identification of the fields in regulations which need to be developed towards fulfilment the requirements of RPAS flights integration in common airspace. The attention was focused on the unmanned aircraft operations on controlled airports and within controlled airports airspaces. The analysis of current RPAS regulations was performed with relation to the classification, safety of flights, certification and existing IFR RPAS procedures. The dependence between mass categorization of RPAS and level of allowed air operations was considered. Selected regulations of international institutions (ICAO, EASA) and national authorities (EU members and outside EU countries) were used. Performed analysis allowed to identify the advance of existing regulations, indicate the advantageous rules for RPAS flights and find the fields in which the further development or modifications are required towards the integration of RPAS IFR flights in common airspace.

Keywords: RPAS, IFR flights integration, common airspace

1. INTRODUCTION

The article concerns the analysis of regulations developed for Remotely Piloted Aircraft Systems (RPAS). The mentioned aircrafts are unmanned flying vehicles which perform non-autonomous flights, controlled by ground operator. RPAS are part of wider family of Unmanned Aircraft Systems (UAS), which comprise both remotely-piloted and autonomous vehicles.

Civil market of RPAS application is recognized as a separate branch of industry. This can extend the potential of manned aviation in the fields of information technologies and other branch of services (ex. delivery or medical care). The development of RPAS industry is supported at European level. An important part of RPAS policy is the integration of RPAS flights into the airspace. European strategy establishes to create the environment for
performing RPAS civil operations integrated with manned aviation in uniform, non-segregated airspace. Currently the dominant model for RPAS operations is airspace segregation which involves the reservation of given airspace volume and do not integrate manned aviation. The integration process requires to solve several problems in technical and regulation fields such as certification, detect and avoid, airspace access, communication, security.

Integration of RPAS is a complex process and it is divided into four main time-frames [11], [12] with gradual goals to achieve:
1. 2013 year – initial rules for Visual Line of Sight (VLOS) flights,
2. 2018 year – initial rules for accommodation (i.e. with some limitations) into common airspace in IFR and Beyond Visual Line of Sight (BVLOS) flights,
3. 2023 year – partial integration in non-segregated airspace,
4. 2028 year – full integration in non-segregated airspace.

The aim of this article is to analyse existing regulations concerning RPAS flights. In particular, the analysis was focused on finding the regulations for operations in TMA areas and controlled airports. Integration of RPAS in TMA areas can bring new opportunities for RPAS services since the controlled airports are located in the neighbourhood of agglomerations. An important aspect of RPAS integration is the scale of unmanned aircraft. The scale of RPAS is mainly categorized with respect to aircraft operational mass. The categorization corresponds with the level of air operations and safety requirements applied. It was shown that RPAS categories strongly differ between the countries. According to the time-frame it was supposed to find initial or prototype regulations for IFR flights. However the integration is on-going process thus the regulations differ between the countries as well. Therefore the existing regulations for each type of RPAS operations were studied. The overall guidance on regulations construction is provided by ICAO regulation [13]. The document applies to RPAS integration in non-segregated airspace and aerodromes. Further on European Union level the RPAS are basically regulated by European Parliament and Council (EC). The EC regulation [9] establishes the EASA institution. The responsibility for regulations was shared between EASA and National Civil Aviation Authorities (CAAs). The regulations for RPAS with MTOM over 150 kg are provided by EASA [8] while CAAs provides regulations for MTOM not exceeding 150 kg. The recent regulation (EC) 2018/1139, [10], develops the rules for RPAS operations range which should be based on risk assessment in particular operation or type of operations. With relation to ATM aspects the regulations are developed by RPAS Steering Group [7]*, [11], [12] (* the publication has consultative character and do not constitute legal regulation) and also CAAs may develop own regulations. Thus the regulations advance is not-uniform due to many different sources of regulations.

Generally, in existing regulations in Europe the dominant RPAS type of operations apply to BVLOS type of flights. The IFR flights of RPAS are allowed in selected countries. However, the existing IFR rules do not distinguish cases for RPAS category thus these systems have to comply with manned aviation regulations. This indicates that existing regulations may be too demanding for smaller RPAS with respect to flight performance. Simultaneously, it is allowed to develop on the national level special IFR procedures for RPAS, including SIDs and STARs [7]. Basing on performed analysis the fields in RPAS regulations where the further development or modifications are required
towards the RPAS integration was identified. The conclusions on potential way to develop RPAS regulations for IFR operations in controlled airports were described.

2. INTERNATIONAL REGULATIONS FOR RPAS OPERATIONS

The international rules for RPAS regulations construction are provided by ICAO organization. Published manual ICAO Doc. 10019 [13] describes the overall guidelines for RPAS regulations in the fields of certification, airworthiness, responsibilities, safety, air operations, aerodrome operations, ATM integrations. From the research goals the ATM integration principles are important. The integration of RPA in non-segregated controlled airspace must comply with existing ATM procedures or if full compliance is not possible, new ATM procedures should be considered by aviation authorities and/or ANSPs in consultation with stakeholders (airspace users).

The basic regulation for RPAS in European Union is provided by European Parliament and Council regulation (EC) 216/2008 [9]. This regulation establishes European Aviation Safety Agency (EASA). According to [9] the regulations for RPAS with MTOM above 150 kg are subjected to EASA while for the RPAS with MTOM below 150 kg are subjected to national Civil Aviation Authorities (CAAs). The development of the regulations for RPAS operations is provided by regulation (EC) 2018/1139 where the range of RPAS operations should be based on risk assessment of particular operation or type of operations [10].

The EASA regulations for RPAS operations are under construction. However, prototype regulation [8] is published and it is supposed to have applicability since 2019 year. The three classes of RPAS are specified: open, specific and certified. The ‘open’ category concerns the smallest vehicles which are intended for wide range of users. This category is subdivided on four groups (A0 ~ A3) with respect to level of flight operations allowed:

- **A0**: 50 m (150 ft) AGL in VLOS and with horizontal distance not exceeding 100 m, GS < 15 m/s, MTOM < 0,25 kg,
- **A1**: 50 m (150 ft) AGL in VLOS, 1st person or follow-me mode, separated from people and obstacles, MTOM < 25 kg,
- **A2**: 50 m (150 ft) AGL in VLOS, 50 m from uninvolved persons, with electronic identification and positioning devices, MTOM < 25 kg,
- **A3**: 150 m (500 ft) AGL in VLOS, 50m from uninvolved persons, with electronic identification and positioning devices, MTOM < 25 kg.

The ‘specific’ category has no strict level of air operations and it is determined for RPAS individually basing on risk assessment. The ‘certified’ category concerns the RPAS for professional applications. This category requires type certification and operator certificate and allows to perform IFR operations. However, this category is not regulated and therefore current EASA regulations do not concern RPAS IFR operations.

Regarding the ATM requirements EUROCONTROL institution coordinate regulations for RPAS integration at European level [7]. Four types of air RPAS air operations are
specified:
- VLL (Very Low Level): up to 500 ft AGL altitude in VLOS or BVLOS,
- IFR/VFR: between 500 ft AGL and FL 600,
- VHL (Very High Level): altitudes above FL 600,
- Transition: mixing of RPAS with manned aviation below 500 ft.

The type of RPAS traffic is divided into 7 classes. The class VI of traffic is applicable for IFR flights in Network, SIDs and STARs procedures. In this class RPAS shall be capable of flying the procedures as designed for manned aviation. This results that integration of large RPAS in IFR flights is privileged. However, on national level it is allowed to accommodate small RPAS in flights above 500 ft basing on risk assessment.

3. NATIONAL REGULATIONS FOR RPAS OPERATIONS

On the national (state) level CAAs may develop own regulations with respect to ICAO standards. Depending on country the regulations advance differs. This concerns RPAS categorization, safety requirements and types of air operations. For selected countries the comparison of RPAS regulations was prepared.

3.1. CLASSIFICATION

The classification is mainly done with respect to aircraft mass. The basic division of 150 kg aircraft mass is remained. Moreover, there are many subcategories of RPAS weight below 150 kg. Table 1 presents the classification in selected countries.

<table>
<thead>
<tr>
<th>No</th>
<th>Country</th>
<th>Classification criteria</th>
<th>RPAS categories</th>
</tr>
</thead>
</table>
| 1  | Australia | MTOM | Micro RPA – weight less than 100 g  
Very small RPA – weight from 100 g and less than 2 kg  
Small RPA – weight from 2 kg and less than 25 kg  
Medium RPA – weight from 25 kg and less than 150 kg  
Large RPA – weight from and over 150 kg |
| 2  | Belgium | MTOM | Class 1. MTOM from 5 kg and up to 150 kg  
Class 2. MTOM less than 5 kg |
| 3  | Croatia | MTOM  
Kinetic energy | Class 5 – up to 5 kg  
Class 25 – from 5 kg up to 25 kg  
Class 150 – from 25 kg up to and including 150 kg  
RPA with kinetic energy up to 79J in free fall is excluded from regulation |
### 3.2. SAFETY REQUIREMENTS

The important safety requirements with relation to RPAS classification are presented below. There are differences in safety level and types of requirements.

#### RPAS safety requirements

<table>
<thead>
<tr>
<th>No</th>
<th>Country</th>
<th>RPAS category</th>
<th>Safety rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Belgium</td>
<td>Class 1</td>
<td>Attestation of R.P.A. Pilot is required</td>
</tr>
</tbody>
</table>
| 2  | Croatia        | Any mass category      | a) RPA operator insurance required in accordance with compulsory traffic insurance regulation  
b) Identification plate or sticker required with the RPA identification tag, name, address and contact information  
c) minimal safe distance from any obstacles, people or animals is 30m; minimal safe distance from group of people is 150 m; minimal safe distance from the airport or approaching/outgoing aircraft is 3km  
d) flights with the distance up to 500m from an operator  
|
Continued Table 2

<table>
<thead>
<tr>
<th>No</th>
<th>Country</th>
<th>RPAS category</th>
<th>Safety rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Czech Republic</td>
<td>Category 2, 3, 4</td>
<td>Requirements (in commercial flights): Built-in safety system for flight terminate is required (for MTOM ≥ 0.91 kg); pilot registration and competence test; authorization to fly; identification label and registration mark; operating manual; occurrences reporting Safety distance (minima): 50 m from person during T-O/landing; 100 m from person /vehicle/construction during flight; 150 m from congested area (horizontal distances) Meteorological minima: clear of clouds for fights in class G airspace; 1500 m horizontal and 300 m vertical distance from cloud for flights in other class of airspace</td>
</tr>
<tr>
<td>4</td>
<td>Germany</td>
<td>Category 1</td>
<td>Operations without authorization allowed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Category 2</td>
<td>Authorization for operations required</td>
</tr>
<tr>
<td>5</td>
<td>Poland</td>
<td>Category 1, 2, 3</td>
<td>Remote Pilot License required for commercial RPAS use. Flights in CTR, ATZ and P, D, R areas after approval.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Category 2,3</td>
<td>Registration in Special category, operational instruction, registration marks are required</td>
</tr>
<tr>
<td>6</td>
<td>Switzerland</td>
<td>Category 1, 2</td>
<td>No authorization required for commercial flights. Minimum 100 m of safety distance around the crowd.</td>
</tr>
<tr>
<td>7</td>
<td>Spain</td>
<td>Category 1, 2, 3</td>
<td>No registration and certification required for MTOM &lt; 25 kg Safety distance of 50 m with respect to buildings/structures/persons RPA operations during the day light and under in VMC T-O/landing zone safety distance of 30 m from persons Overflight of industry/transport/energy infrastructure in safety distance of 50 m vertical and 25 m horizontal Minimum pilot age 18, medical certificate, proof of aircraft/pilot theoretical knowledge (pilot license, etc.)</td>
</tr>
<tr>
<td>8</td>
<td>United Kingdom</td>
<td>SUA</td>
<td>Required: operating permission and pilot qualification</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Light UAS</td>
<td>Required: airworthiness approval, registration, operating permission, pilot qualification</td>
</tr>
</tbody>
</table>

3.3. TYPE OF AIR OPERATIONS

The majority of countries already have regulations for BVLOS operations in uncontrolled airspace. If flights in controlled airspace are allowed, the additional restrictions usually exist. It was supposed to find existing regulations IFR operations in controlled airspace. However, only few countries regulate this type of air operations.

Table 3

<table>
<thead>
<tr>
<th>Nr</th>
<th>Country</th>
<th>RPAS category</th>
<th>Airspace operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Australia</td>
<td>Very small, small, medium, large</td>
<td>Controlled airspace IFR operations allowed under conditions. Area must be approved for RPAS operations in accordance with ATC clearance. Radio communication is required.</td>
</tr>
</tbody>
</table>
### 4. CONCLUSIONS

The general development of RPAS regulation progress in accordance with applied in Europe time-frame. Most of countries have already regulations for flights in VLOS in uncontrolled airspace. These types of flights are suitable for EASA ‘open’ categories A0–A3. The VLOS flights cover VLL type of air operation specified by
EUROCONTROL. It can be seen that national regulations for these types of flights corresponds with international regulations. However, the national regulations in some cases allow to operate aircrafts between 25 and 150 kg (heavier than A3 category) while the maximal height can be beyond 500 ft (ex. Germany). On the other hand BVLOS operations are not common even being allowed in VLL operations. This type of operations in most cases cannot be treated as integration since segregation of airspace is required (ex. Poland). Thus there is still a gap for development of BVLOS rules for integration.

The regulations development for flights in controlled airspace is more complex. The ICAO guidance provides a background to put RPAS flights in controlled airspace in IFR/VFR flights and controlled airport operations. However, the principles of integration the controlled airspace operations are not detailed therefore stakeholders have to develop the regulations to comply general requirements. Both international institutions and CAAs may develop regulations for flights in controlled airspace. Thus the advance in IFR regulations is not-uniform. At European level, the regulations for certification specifications are undeveloped yet. This result in differences in requirements for certification on national level. The ATM guidelines for IFR operations allow to put RPAS flights into Network, SIDs and STARs procedures (Class VI of traffic, EUROCONTROL). In principle RPAS shall comply with procedures designed for manned aviation. This is caused by safety of operations in mixed environment and it is beneficial for large scale RPAS. Only few countries have basic regulations for RPAS IFR operations (ex. Australia, Poland, and United Kingdom). Simultaneously, these regulations require complying with manned aviation procedures and level of equipment. The requirement for manned aviation procedures compliance cannot be treated as a restriction. More, it should be noted that having no pilot on-board the additional procedures for safety of flights may be required. The good example is United Kingdom regulations which regulate method for terrain clearance and loss of control or critical failure procedures.

On national level there is a potential for small RPAS integration into IFR flights. Most of countries specify an RPAS category with operational mass between 25 kg and 150 kg. The performances of this category allow to perform professional applications despite the cruise, climb or descent performance profile could be lower than manned aviation. It is also allowed at national level to accommodate small RPAS in controlled airspace basing on risk assessment. This creates a field for research in fitting small RPAS into controlled airspace. The ICAO principles for RPAS integration foreseen the development procedures designated for small RPAS. For these controlled airports in which traffic is relatively at low level the small RPAS could operate. This can extend the potential of RPAS services market. This is because specialized services of RPAS are expected over agglomeration/industrial areas where small RPAS will be competitive to other types of aviation.

5. ACRONYMS

ANSP – Aeronautical Navigation Services Provider
ATM – Air Traffic Management
BVLOS – Beyond Visual Line of Sight
CAA – Civil Aviation Authority  
EASA – European Aviation Safety Agency  
EVLOS – Extended Visual Line of Sight  
ICAO – International Civil Aviation Organization  
MTOM – Maximum take-off mass  
RPAS – Remotely Piloted Aircraft System  
SID – Standard Instrument Departure  
STAR – Standard Instrument Arrival  
TMA – Terminal Manoeuvring Area  
VLOS – Visual Line of Sight  
VLL – Very Low Level  
VMC – Visual meteorological conditions

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**ANALIZA REGULACJI DOTYCZĄCYCH LOTÓW IFR SYSTEMÓW BEZZAŁOGOWYCH RPAS W PRZestrzeni Kontrolowanej**

**Streszczenie:** Aparaty latające klasy RPAS *(Remotely Piloted Aircraft Systems)* stanowią grupę bezzałogowych aparatów latających, wykonujących loty nieautonomiczne, nadzorowane przez naziemnego operatora. Rynek cywilnych zastosowań RPAS jest dynamicznie rozwijającą się gałęzią przemysłu. Strategia europejska zakłada stworzenie warunków do wykonywania cywilnych operacji RPAS we wspólnej przestrzeni powietrznej (docelowo na lata 2024–2028). Obecnie, w Europie, dominującym modelem wykonywania lotów RPAS jest segregacja przestrzeni powietrznej. Celem niniejszej pracy jest identyfikacja obszarów regulacji wymagających rozwoju w kierunku spełnienia wymogów integracji lotów RPAS we wspólnej przestrzeni powietrznej. Uwzględniono relację między kategorizacją masową samolotów bezzałogowych oraz operacjami powietrznymi dostępnymi dla RPAS. Wykonano analizę obecnego stanu regulacji lotów RPAS uwzględniając zagadnienia klasyfikacji RPAS, bezpieczeństwa lotów, certyfikacji, możliwości adaptacji do istniejących procedur IFR. Analizie poddano wybrane regulacje międzynarodowe (ICAO, EASA) oraz państwowe (wybranych państw Unii Europejskiej oraz państw spoza UE). Pozwoliło to na identyfikację różnic w istniejących regulacjach oraz wskazanie potencjalnie korzystnych praktyk i obszarów wymagających rozwoju lub modyfikacji w kierunku integracji lotów RPAS IFR we wspólnej przestrzeni powietrznej.

**Słowa kluczowe:** RPAS, integracja lotów IFR, wspólna przestrzeń powietrzna

**PJ.10 PROSA**

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