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# "OPEN" CATEGORY UNMANNED AERIAL SYSTEMS HARMONIZED STANDARDS AND REQUIREMENTS COMPLEX

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***Abstract:*** *The steadily increasing use of unmanned aerial systems (UAS) is an important factor for the military and civil aviation safety on a global scale. One of the critical conditions for the efficient functioning of the European aviation safety system is the establishment and implementation in practice of a comprehensive regulatory framework for the use of unmanned systems in the Common European Airspace. The aviation authorities and industry strive to introduce a set of rules and requirements that adequately and flexibly guarantee a high level of safety without limiting the development of the UAS market. This article proposes a set of standards that should be met by "Open" category UAS with the intention to execute operations in the European airspace.*

**Keywords: UAS, regulations, "open" category, standards**

## 1. Introduction

In recent years, there has been an increasing trend of the traffic in the common European airspace. It is certain that this will continue in the future, but with a distinct feature - passenger and cargo aircraft, light aircraft and helicopters will increasingly share this space with unmanned aerial vehicles (UAV). The unambiguousness of the fact is confirmed by the statistical analysis of this aviation industry branch. Marketing analysts predict that for a period of 11 years (2016-2027), the unmanned aerial system (UAS) market will mark an average annual growth of about 30% up to 70 bn USD (Fig. 1) [1].

However, the widespread use of UAS raises a number of risks and challenges for the aviation security and safety systems, which requires the establishment and practical implementation of a comprehensive European regulatory framework about using such a vehicle in the European airspace [2], [15].

Integrating them into the civil aviation system requires an innovative approach to promote a promising and competitive European industry, creating jobs and economic growth. The future regulatory framework must ensure the necessary level of safety and environmental protection acceptable to society and to provide enough flexibility for the development and adaptation of the new industry using the advantages of unmanned aviation technologies [3].

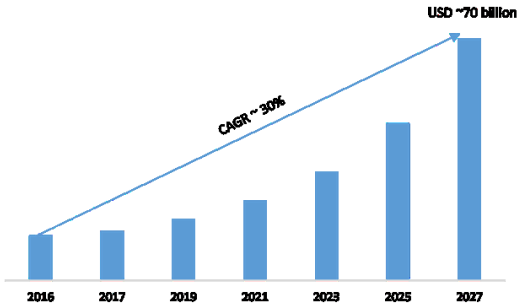


*Figure 1: Market status and primary cost forecast of UAS on a yearly base in billion USD (according to Market Research Future)*

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The main objectives of this research are:
- to highlight the need of a comprehensive regulatory framework for the use of UAS in the Common European Airspace;
- to present the main ideas and initiatives of the aeronautical authorities and industry in its development;
- to define the baseline requirements for "Open" category UAS and operations by dividing them into four subclasses.

## 2. The Need of a UAS Comprehensive Regulatory Framework

The official Federal Aviation Administration (FAA) statistics analysis about the UAV usage in the USA airspace shows that by 2018 the certificates issued for small UAV commercial operators exceeded 60,000. This seems insignificant compared to the nearly 800,000 registered small UAV for non-commercial purposes - sport and entertainment, which is 2,5 times more than the registered piloted aircraft over the same period [4].

These statistics may look a bit different if someone does not consider the accident that occurred in 2017 near the shores of Staten Island, New York. In fact, this is the first recorded case of collision between unmanned and piloted aircraft.

The event occurred on September 21st at twilight, at about 300 feet (90 meters) above Staten Island's beach (Fig. 2). In the accident, there were involved two UH-60 Blackhawk US Army helicopters and a small UAV produced by DJI company whose model ("Phantom 4") was identified during the investigation [5].

This is the only such incident so far, but according to the FAA statistics submitted to the US Senate Committee on Commerce, Science, and Transportation, the reported cases of detected UAV from the board of piloted airplanes vary between 1,200 and 1,800 each year [6].

Recognizing the increased risk of the rapid propagation of unmanned technologies for different purposes, the European aviation authorities adopted a roadmap for improving the regulatory framework in this aviation safety direction. The process of fully integrating UAS into the airspace with all other users is likely to be long and difficult, but it must not be postponed [7].

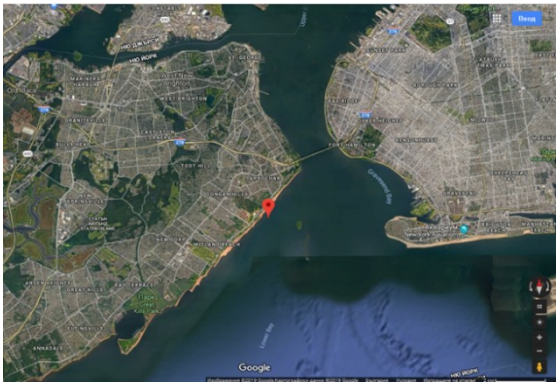



*Figure 2: UH-60 and Phantom 4 accident area*

## 3. The European UAV regulatory framework development time line

In 2008, the EU laid the foundations of the European UAS regulation. In Annex II to the European Parliament Regulation (EC) No. 216/2008, it was clarified that UAV with a maximum take-off weight (MTOW), not exceeding 150 kg shall be classified as aircraft, but not be subject to the rules of the Regulation. For larger vehicles, all General Aviation requirements and rules are applicable. Although unheeded, UAShad appeared in the European aviation safety system agenda, becoming an increasingly important factor for it [8].

In 2015, the development of a unified regulatory framework on UAS operations, which should be valid for all member states and countries under the control of the European Aviation Safety Agency (EASA), was started.

The process was initiated by the publication of the Riga Declaration in March 2015, which was the final product of a meeting between the representatives of the European Aviation Community and the European Commission, the EASA Executive Directorate, UAS manufacturing and maintenance organizations, during the

Latvian Presidency of the European Council, entitled "Framing the Future of Aviation"[9].
The next significant initiative in terms of the regulatory formation, which resulted in the Declaration of "Drones as leverage for jobs and new business opportunities", was the Warsaw meeting in 2016. At this meeting, the participants insisted on several well-coordinated actions to U-Space "ecosystem" development until 2019, based on the guiding principles set out in the Riga Declaration (Fig. 3).


*Figure 3: U-Space ecosystem*

U-Space is a mobile application designed to manage and control UAS operations conducted at heights up to 150 m above ground level (AGL), mainly in urban environments.
The application should allow trajectory and flight profile planning by the operator as well as their dynamic automated in-flight preplanning in order to avoid conflict situations with other unmanned, manned vehicles or obstacles [10].
In 2018, following the two declarations and the roadmap published by EASA, a new European Regulation on general aviation rules (EU) 2018/1139 was adopted.
Now the European aviation safety experts are united around the notion that the UAS operations must be regulated in a way proportional to the level of risk. Given the wide range of UAV classes and operations, the European regulatory framework is expected to be built around the definition of three categories and the associated with them regulatory regime: "Open", "Specific" and "Certified".
This concept is expected to achieve two main goals:
- integrating UAS into the existing aviation system in a safe and proportionate manner;
- promoting innovative and competitive European technologies and industry and creating new employment.
It also allows for commercial and non-commercial operations to be placed on an equal footing, focusing not only on aviation safety risks, but also on the risks to privacy, security of the individual and property. These include collision with manned or other unmanned vehicle, injury to a person or damage to property, particularly regarding critical infrastructure [2].

## 4. Key Aspects of "Open" Category UAS and Remote Identification Add-Ons Regulation

The "Open" category of operations should not be subject to classic aeronautical compliance procedures. It refers to UAS, executing operations with low level of risk that does not require aviation authority's permission (limited within a given airspace area). Authorization is not required for conducting commercial operations and there is no need to issue UAS airworthiness, pilots and operators' certificates from the national aviation authorities [17].
So, important features of this category are the high level of airspace freedom of usage and the minimal qualification requirements for the subjects operating with such a vehicle. This allows rapid and easy experience gaining from small and medium-sized traders operating in the service sector [16].
However, the member states should take the necessary steps to ensure that UAS intended to be operated in the "open" category are made available on the market and put into service only when they do not

compromise the health and safety of individuals, domestic animals or property, other manned and unmanned aerial vehicle when normally used [11].

In accordance with this, a set of obligations and synchronized standards applicable to an "Open" category UAS is proposed. They would provide the necessary level of safety without imposing additional requirements on their users other than those set out in Regulation (EU) 2018/1139. They could be presented in five main sections (Fig.4).

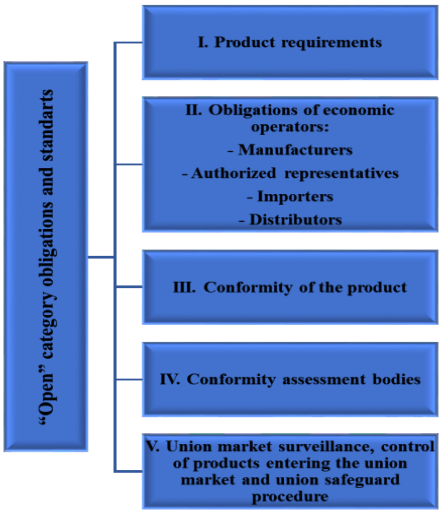



*Figure 4: "Open" category obligations and standards*

The following part of the paper describes the standards that can be defined in the first main section – "Product requirements". For this purpose, they are decomposed into two groups (Fig.5).

The first one includes "Open" category unmanned systems standards divided into five subclasses - from C0 to C4, and the second one includes standards and requirements for a direct remote identification (DRI) add-ons [12].

*A) "Open" category UAS subclasses standards* - this group includes proposed standards which should be applied to any UAS intended to be operated in the "Open" category that is new to the Union market, whether a new system made by a manufacturer established in the Union or a new or second-hand UAS imported from a third country.

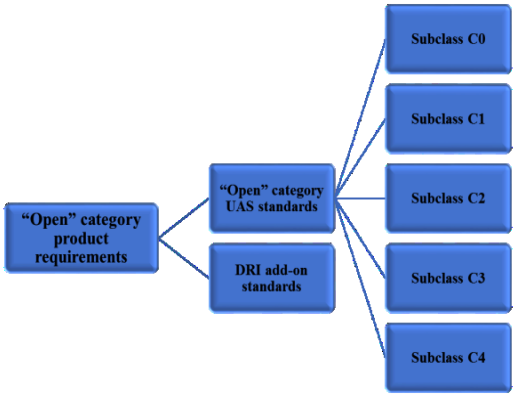
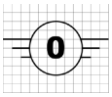


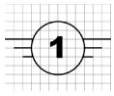

*Figure 5: Decomposing UAS "Product requirements" standards*

*1. Class C0 UAS bears the following class identification label and should comply with the following:*




- MTOW of less than 250 g, including payload;
- maximum speed in level flight of 19 m/s;
- maximum attainable height limited to 120 m AGL;
- safely controllable with regards to stability, manoeuvrability and data link performance, by a remote pilot following the manufacturer's instructions, as necessary under all anticipated operating conditions including following the failure of one or, if appropriate, more systems;
- constructed in a way to minimize injury to people during operation;
- powered by electricity with nominal voltage not exceeding 24 V DC or equivalent AC voltage;
- if equipped with a follow-me mode and when this function is on, be in a range not exceeding 50 m from the remote pilot, and make it possible for the remote pilot to regain control of the UAV;
- the user's manual describing: the characteristics of the system, clear operational instructions, operational limitations and appropriate description of all the risks related to UAS operations adapted for the age of the user;
- information notice published by EASA providing applicable limitations and obligations, in accordance with the regulations.

*2. Class C1 UAS bears the following class identification label and should comply with all standards specified for class C0 and additionally:*



- maximum attainable height limited to 120 m AGL or be equipped with a system that limits the height to 120 m AGL or to a value selectable by the remote pilot. If the value is selectable, information about the altitude during flight should be constantly provided to the remote pilot;
- physical characteristics such as to ensure that the impact energy transmitted to the human head is less than 80 J, or, as an alternative, MTOW less than 900 g, including payload;
- in case of a loss of data link, have a reliable and predictable method for data link recovering or flight termination;
- guaranteed and indicated A-weighted sound power level (MSPL) not exceeding the values defined in Table 1 unless it is a fixed-wing vehicle [14];

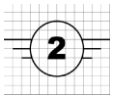
*Table 1 "Open" category MSPL*

| **Class** | **Maximum sound power level, dB** | | |
|---|---|---|---|
| | as from entry into force | as from 2 years after entry into force | as from 4 years after entry into force |
| C1 | 85 | 83 | 81 |
| C2 | $85 + 18{,}5\ lg\frac{m}{900}$ | $83 + 18{,}5\ lg\frac{m}{900}$ | $81 + 18{,}5\ lg\frac{m}{900}$ |

** m – MTOW of the UAV*

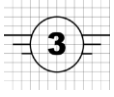
- direct remote identification (DRI) that should comply with the standards defined in subsection B;
- geo-awareness system that provides: interface to load and update data containing information on airspace limitations related to UAV position and altitude imposed by the geographical zones; warning alert to the remote pilot when a potential breach of airspace limitations is detected; information to the remote pilot on the UAV's status as well as a warning alert when its positioning or navigation systems cannot ensure the proper functioning of the geo-awareness system;
- low battery level warning;
- lights equipment for the controllability of the vehicle and the conspicuity at night;
- the user's manual additionally describing: procedure to upload the airspace limitations; maintenance instructions; troubleshooting procedures;

*3. Class C2 UAS bears the following class identification label and should comply with all standards specified for class C1 and additionally:*



- MTOW less than 4 kg, including payload;
- the tethered UAV should have a tensile length of the tether less than 50 m and a mechanical strength no less than 10 times the weight (for heavier-than-air vehicles) and 4 times the sum of the maximum static thrust and the aerodynamic force (for lighter-than-air vehicles);
- in case of a loss of data link, have a reliable and predictable method for data link recovering or flight termination (except for the tethered UAV);
- equipped with a protected data link against unauthorized access (except for the tethered UAV);
- equipped with a low-speed mode limiting the maximum cruising speed to no more than 3 m/s (except for the fixed-wing UAV);
- powered by electricity with nominal voltage not exceeding 48 V DC or the equivalent AC voltage;

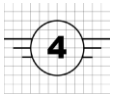
*4. Class C3 UAS bears the following class identification label and should comply with all standards specified for class C2 and additionally:*



- MTOW less than 25 kg, including payload and maximum characteristic dimension of less than 3 m;
- indicated A-weighted sound power level;

*5. Class C4 UAS bears the following class*

*identification label and should comply with the following:*



- MTOW less than 25 kg, including payload;
- safely controllable with regards to stability, manoeuvrability and data link performance, by a remote pilot following the manufacturer's instructions, as necessary under all anticipated operating conditions including following the failure of one or, if appropriate, more systems;
- not capable of automatic control modes except for flight stabilization and lost link assistance;
- the user's manual describing: the UAS characteristics; clear operational instructions; maintenance instructions; troubleshooting procedures; operational limitations and appropriate description of all the risks related to UAS operations;
- information notice published by EASA providing applicable limitations and obligations under EU law.

*B) "Open" category DRI add-on standards* –this groupcontains sample standards for UAS identification tools and equipment. According to the new regulations, all DRI add-ons should comply with the following:
- allow the upload of the UAS operator registration number, exclusively following the process provided by the registration system;
- have a physical serial number compliant with standard ANSI/CTA-2063 Small Unmanned Aerial Systems Serial Numbers, affixed to the add-on and its packaging or its user's manual in a legible manner;
- ensure, in real time during the whole duration of the flight, the direct periodic broadcast using an open and documented transmission protocol, of the following data, in a way that they can be received directly by existing mobile devices within the broadcasting range: 1) UAS operator registration number; 2) unique physical serial number of the add-on compliant with standard ANSI/CTA-2063; 3) geographical position of the vehicle and its height AGL; 4) route course measured clockwise from true north and ground speed of the vehicle; 5) geographical position of the remote pilot or, if not available, the take-off point;
- ensure that the user cannot modify the mentioned data;
- are placed on the market with a user's manual providing the reference of the transmission protocol used for the direct remote identification emission and the instruction to install the module on the UAV and to upload the UAS operator registration number [13].

## 5. Conclusions

The proposed harmonized standards combine some of the basic technical and operational "Open" category UAS requirements. They highlight the requirements to the flight control and operations management technical systems that should comply with the unmanned platforms in this category to ensure privacy, security of the individual and property. These include collisions with manned or other unmanned aircraft, injury to a person, or damage to property, particularly regarding critical infrastructure. They could supplement the evolving European regulatory framework for the use of such platforms with the aim of preparing the European market and the aviation safety system for their even more intensive use in the Common European Airspace.

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