

## CURRENT STATE OF THE SMALL RPAS MAINTENANCE IN THE CZECH REPUBLIC

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*Summary: This paper summarize a current state of a small unmanned aerial vehicles maintenance at the territory of the Czech Republic. The word “small” means unmanned vehicles with the maximum take-off mass not exceeding 20 kg. A reader becomes familiar with a RPAS (Remotely Piloted Aerial Systems) maintenance issues an also with a legislation in the first part of the paper. The legislation determines requirements for their maintenance. The next part describes the current state of this type of the maintenance. The last part of the paper deals with the future of the small RPAS maintenance. There is a rough estimate of a future maintenance development in this part of the paper. There also are a possible solutions of these issues in this part. These things are there because the authors think that there is a space for a RPAS maintenance improving.*

*Key words: RPAS maintenance, UAV maintenance, unmanned vehicle maintenance, maintenance in the Czech Republic, RPAS in the Czech Republic, UAV in the Czech Republic, current state of a maintenance.*

### INTRODUCTION

A flying with aircraft models has happened in the Czech Republic (CZE) for several decades. An unmanned vehicles expansion for a usage in a commercial sphere has also passed. It means that there is a big number of the RPAS here in CZE. These RPAS are used for the commercial and also for a recreational purpose. An effect of these events causes changing of the legislation or creation of a new one. It happens mainly things to big usage in the commercial sphere. Regulations focuses on many branches starting with pilot training and ending with RPAS operations manuals. We focus on the maintenance in our paper. The maintenance is an integral part at a process of an ensuring a safe RPAS working.

The paper focuses on the maintenance of the RPAS with the maximum take-off mass of 20 kg for the following reasons. It can be assumed that bigger unmanned vehicles have more complex systems and they are close to manned aircraft in the matter of their construction. In this cases, the RPAS maintenance will be similar to the maintenance of the manned aircraft. It means that the best to do is to applicate the same maintenance that is used at the manned aircraft. This statement could not be true for the small RPAS.

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The paper only deals with the Czech Republic because each member state of the European Union (EU) has its own RPAS legislation. The regulations of each state is more or less the same and the dealing with the maintenance of each state goes beyond this paper.

Of course that there are the regulations which determine how to do the RPAS maintenance. But according to the authors there is a space for improving this maintenance. They try to clarify their opinion in the following lines.

But before we move on to solution itself it would be nice to explain a partition of each chapter. There are two different types in the RPAS operation. The recreational flying and the commercial one. A flying for our own pleasure or a sport flying can be placed under the recreational flying. Aerial works, aerial works for our own use and experimental or scientific flying can be placed under the commercial flying. Because of that the Czech Republic legislation regulates these two types differently, each chapter is specifically partitioned to the recreational and commercial flying.

## **1. LIGISLATION**

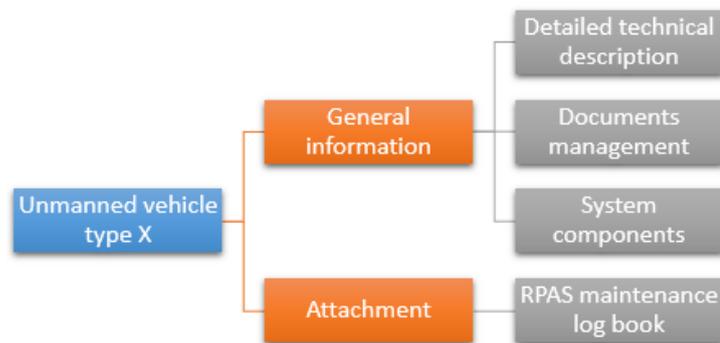
There is mentioned the current legislation of the Czech Republic in this chapter. This legislation regulates the RPAS maintenance.

### **1.1 Recreational flying**

The RPAS maintenance is not exactly defined within the recreational flying in the CZE. The whole operation, so the maintenance too, is regulated by the Aviation Regulation L2 – Rules of the Air (1), more precisely the Attachment X. It is obvious from this regulation that an RPAS operator is responsible for a safe RPAS working. It means that he/she is responsible for the RPAS maintenance too. The regulation does not specify how and when the maintenance should be done.

### **1.2 Commercial flying**

The legislation is, in case of the commercial flying, stricter. The base is the regulation L2 (1). It is the same like for the recreational flying. It is obvious from the regulation that it is necessary to have the operations manual. There is a template (2), which can be downloaded, for the operations manual creation at the Czech Civil Aviation Authority websites (<http://www.caa.cz/>). One part of the template and also one part of each operations manual is about maintenance procedures. It is obvious from the template that if a RPAS producer gives a manual, in which there is a detailed technical description of the RPAS and maintenance program, this manual can be used completely or partly for the maintenance procedures part of the operations manual. But the producer's manual must be in accordance with the Aviation Regulation L6/I (3). If there is not such a manual, the detailed technical description and maintenance program must be created by the operator. This created manual must be in accordance with the Aviation Regulation L6/I too. The structure of the maintenance part included in the template is in fig. 1.

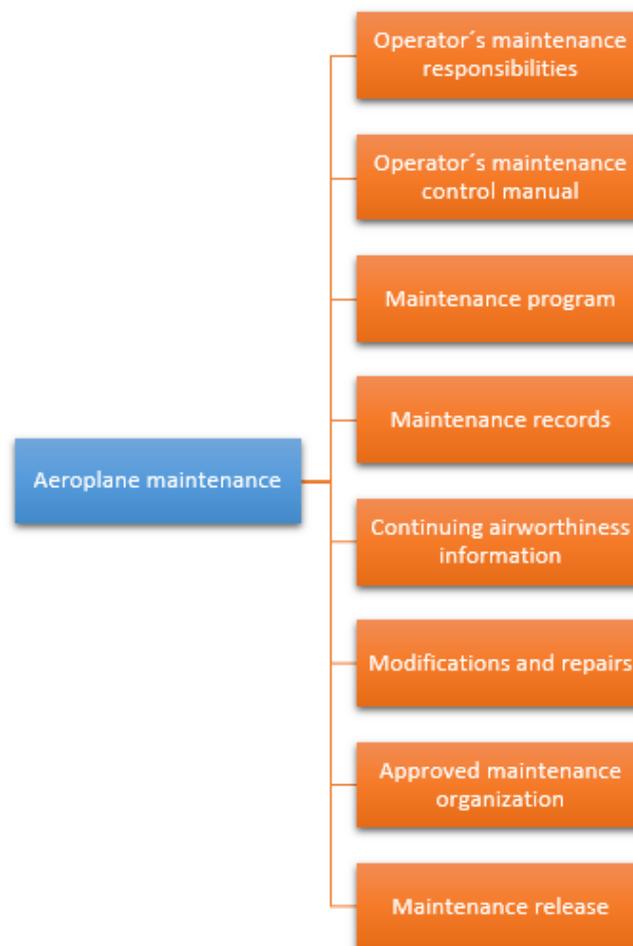


Source: The CAA template

Fig. 1 – The structure of the RPAS operations manual, Part E – Maintenance procedures (2).

There can be several RPAS types within the Part E (typ X, Y...).

The Aviation Regulation L6/I deals with the Operation of Aircraft. The aeroplanes maintenance is defined within this regulation. The basic structure of a maintenance chapter is in fig. 2. This regulation has been created for manned aircraft. Some requirements, which are listed in this regulation, can be too strict or unsuitable for the RPAS. On the other hand, some requirements, which are suitable for the RPAS, might not be listed.



Source: The Aviation Regulation L6/I

Fig. 2 – The structure Chapter 8 – Aeroplane maintenance which is listed in the regulation L6/I (3).

## 2. CURRENT STATE OF THE RPAS MAINTENANCE

Before moving to a description of the current state at the recreational and commercial flying, 3 basic ways how to make the RPAS maintenance program are going to be shown. In other words, the program can be made according to what. There is a summarization of advantages and disadvantages of these ways in the tab. 1.

1. *Producer's manual* – at this case, the RPAS manual is given together with the RPAS. This manual also contains the maintenance program. The maintenance itself is done according to this manual. This way of creating the maintenance program is the easiest one. The problem is that almost every producer of the small RPAS has not and does not give such a manual.
2. *Existing maintenance program* – this way benefits from the maintenance program that is already made for the same or similar RPAS type. Basically, you can take (borrow, buy, rent...) the program from someone and use it or modify it according to your needs. The problem is in looking for such manuals or in their price.
3. *New maintenance program* – this way of making the maintenance program is probably the most demanding one. Basically, it means that you create a new program according to the regulations. But it is time consuming and a skilled person is needed.

Tab. 1 – The table of the advantages and disadvantages of the ways how to create the maintenance program.

<i>way</i>	<i>advantages</i>	<i>disadvantages</i>
<b>producer's manual</b>	<ul style="list-style-type: none"> <li>• easy to do</li> <li>• the cheapest one</li> </ul>	<ul style="list-style-type: none"> <li>• producers have not such manuals</li> </ul>
<b>existing maintenance program</b>	<ul style="list-style-type: none"> <li>• easy to do</li> </ul>	<ul style="list-style-type: none"> <li>• looking for them</li> <li>• high price</li> </ul>
<b>new maintenance program</b>	<ul style="list-style-type: none"> <li>• the manual is according to you</li> </ul>	<ul style="list-style-type: none"> <li>• hard to do</li> <li>• time consuming</li> <li>• skilled person is needed</li> </ul>

Source: Authors

### 2.1 Recreational flying

Because of that the legislation does not regulate the maintenance demands within the recreational flying, the current state of a doing the maintenance is quite easy. The maintenance after a failure is used. If there is a damage or destruction of some part of the RPAS, the part is repaired or changed for a new one. A detection of the failures is mostly realized during a pre-flight visual check or during a visual check done at home. Hidden failures are mostly found during a flight. The pilot finds out that the RPAS behaves abnormally. There are some cases that aircraft models are operated with small failures. The result of this maintenance can be reduction of the RPAS safety and a foreign affairs threats or a person threads.

## **2.2 Commercial flying**

The RPAS operator, which uses the RPAS for the commercial purposes, must have the maintenance program and he/she must follow it. But the situation is that the maintenance is more or less similar to the case of recreational flying. Of course that we do not want to say that the RPAS operators does not follow the regulations. We want to say that the manuals and maintenance programs are simple and they are based on the maintenance after failure. This type of the maintenance results in less confidence in the RPAS safety. This influences many things. For instance, a decision where the RPAS can be operated, if Fail-Safe systems are needed est. The maintenance program is made according one of the three mentioned ways.

## **3. VISIONS FOR THE FUTURE**

There is an author's opinion to the small RPAS maintenance and proposals how to improve it in this chapter.

### **3.1 Recreational flying**

The current maintenance that is used in the recreational flying is sufficient. If the regulations that define flight spaces are respected, there is no reason to be afraid of that the maintenance after failure is used. Only the operator's RPAS is damaged in the vast majority. So there is no reason to do any changes in the regulations that are valid for the recreational flying.

During the sport flying, especially at races, the risk of damaging other RPAS, other objects or other people (other pilots, audience etc.) is bigger because of the bad maintenance or the RPAS failure. Because of this, the race RPAS should have the maintenance program, records about performed maintenance and some insurance that is similar to the car insurance. The maintenance program could be done similarly or in same way like it is written in the next subchapter.

### **3.2 Commercial flying**

The regulations, which have been mentioned above, are approved and sufficient. This is not mean that there is not a space for improving them. The biggest disadvantage of the existing regulations is that they have been created for manned aircraft. The unmanned aircraft have their own specifics and they should not be ignored during the maintenance and even during the creation of new documents.

The problem is at the very beginning. In other words, producers does not give necessary manuals, mainly the maintenance ones. The whole problem of a bad documentation could be solved by the way that already works. It is proven for decades. This way is Maintenance Review Board. This group has existed from the sixties of the last century. The group consist of aircraft producers, operators, parts suppliers and civil aviation authorities (CAA). The result of its work is the foundation block, which is used for the creation of the maintenance program, used for most manned aircraft. This block is Maintenance Review Board Report (MRBR). It forms a package of the manuals together with the producer's manuals and requirements from the CAA or other organizations. A complete and clear maintenance

program develops from this package (4). If there had been such a manual for unmanned systems, many problems, which occur because of using the regulations and manuals defined for the manned systems, would have been solved. It might be good to create the MRBR for the RPAS. This could cause the improvement at the RPAS maintenance. It might be good to do a regulation for the commercial RPAS producers too. This regulation should mandating that the producers would have to give the detailed maintenance manuals. The operator would have to create the maintenance program in the same way like it is making for manned aircraft now.

## CONCLUSION

The current state at the small RPAS maintenance enables the recreational and also the commercial flying and everything is according the regulations. But there is some space for the improving. This space could be utilize in the future to prevent the problems that could occur because of a using the regulations made for the manned aircraft. It is possible that there will be a time when the current legislation will become inconvenient. And when the time comes, a better variant should be prepared. Otherwise, the serious problems could occur. The content of this paper might help improve the current state and to develop new regulations at a field of the RPAS maintenance.

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