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Proposal to Replace the Defectoscopy Method On a Selected Aircraft Component

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Abstract

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The need to use aircraft in a flight-ready condition requires regular servicing. Some of the actions can only be performed in specialized establishments where these actions can be performed. Service inspections and related procedures are carried out in accordance with the customer's requirements, when it is necessary to subject the given component to an inspection, i.e., an inspection. Just as all pilot-controlled vehicles require regular servicing, the principle of regular servicing is also required for all unmanned aerial vehicles (gyroplanes). cracks or internal damage may appear in the material during operation. These damages can be a material defect, material fatigue or operational wear. The biggest and indisputable advantage of the scope of non-destructive testing is that we can detect errors or mistakes earlier since they could have caused more damage. Another indisputable advantage is saving time.

Keywords
Aircraft maintenance, fetoscopy, safety

Informácia
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1. Introduction

Aviation industry maintenance is a complex process involving all members from the pilot, cabin crew, and service staff to the cleaning service. Everyone can report to the mechanic or pilot a finding that they do not like and, according to their observations, is no longer under the operational state of the equipment. The pilot and the mechanic are authorized personnel to write findings or damage in the logbook. An authorized mechanic must meet all the administrative requirements based on the regulation PART 66. This regulation specifies the requirements placed on technical personnel providing maintenance, whether on the line or heavy maintenance, i.e., hangar maintenance. A self-employed mechanic must hold a license and type training for the given type of aircraft. He should also have demonstrable experience in the given field, and this should be supported by a book with records of his experience.
Technical personnel ensuring the maintenance of aircraft equipment are in most cases employees of the maintenance organization. An organization with a maintenance permit should meet the minimum requirements based on regulation 1321/2014 [1]. The powers and duties of individual members of such an organization are precisely defined in this regulation. If the organization meets the minimum requirements, it will receive a registration number under which the maintenance is carried out. As mentioned, maintenance can be performed directly on the aircraft stand or in the hangar. Minor repairs or replacement of components are carried out at the stand, where no specialized equipment is needed. An example of such maintenance is, for example, the replacement of engines. In this case, the machine is considered a component, as it has its serial number. Hangar maintenance is more specific. Inspections are carried out in covered areas when it is necessary to dismantle the aircraft. The start of maintenance in the hangar premises is defined as the first phase. At this stage, the aircraft is pushed into the hangar. After the aircraft is pulled into the hangar, initial inspection work begins simultaneously with the opening of the aircraft. Opening the aircraft refers to the removal of panels, access and inspection points located on the aircraft cover. These panels, even if they are the same type of aircraft, may differ, as the configuration of the aircraft may not be the same.

The second phase, which takes up the largest part of maintenance, is the inspection itself. As for the possibility of performing an inspection in terms of qualifications, it varies depending on the organization. For example, Lufthansa Technik has its internal qualification assessment of maintenance personnel. However, the result of the work must be the same and the aircraft must technically meet the parameters set by the manufacturer, which are under the regulations set in the manuals and also by the relevant authority. During the inspection, various tests are performed to determine the technical condition of the aircraft. These tests are performed by specialized personnel. The technique used in the tests is non-destructive testing technology. This technology makes it possible to determine the technical condition of the aircraft and its components, without the tested and examined parts being damaged or degraded. We know various methods of non-destructive testing that are used to detect damage to aircraft equipment. Already during this phase, the resulting damages are revealed and marked as findings in the electronic system. Findings are assigned to individual qualifications so that this defect or find can be removed using the appropriate manual and the corresponding work procedure to repair the damage.

2. Basic theory

In practice, in the maintenance of aircraft technology and its components, we encounter non-destructive testing almost constantly. Considering that the visual inspection is performed every day, in the expected cases this aircraft's condition can be up to the nearest point where the aircraft is on the ground for the time required for this inspection. Non-destructive testing methods are more widely used during so-called heavy maintenance when components or structural aircraft units are checked in their own prescribed manner by a directly determined regulator. It often happens that it is necessary to alternate several methods to reach a state where the technician is sure that the given component or structural unit can be put into operation and meet the requirements of the reliably prescribed cycle until the next inspection.

Most of the components or structural units are subject to structural stresses and to atmospheric influences such as weather. These influences together can lead to wear and tear, and an inappropriate method can lead to a fatal outcome, when surface damage is not detected, which over time will grow into structural damage. Then the fracture of the material can occur. At best, we are talking about an incident. Damage to a component can also have fatal consequences with loss of life.

For A320MW wheel aero component maintenance, four testing methods are used for aircraft damage that may occur during in-service operation.

The first basic method is a visual inspection. No special processes or means of inspection are required to perform a visual inspection. It is most often performed with the naked eye or with a magnifying glass [3].

The second easily performed method is the penetration method. Rather, the value of this method is that it is relatively cheap and available. It can be used to detect a surface defect such as a crack, deep scratch, or porosity. The penetration method offers the possibility of checking a large surface in a relatively short time [4].

The third method is defectoscopy using the magnetic method. This method is suitable for the use of surface and near-surface defects of components made of ferromagnetic material. If the component is undamaged, it is only magnetic inside the material. If there is a magnetic crack or other damage in the component, it will cause field leakage in the vicinity of the crack or defect. The magnetic flux thus escaped is shown by covering the surface with fine sawdust of a metallic and magnetic nature. These fine ferromagnetic filings are applied either dry or in liquid. The particles are then grouped in the place of damage and thus indicate to us where the defect is located. The method can be used for all metals that can be strongly magnetized [5].

The fourth method is the method of eddy currents.
The method of expected currents could be described as a very large control from a time point of view. Inspection by this method is not only a surface defectoscopy method but also a deep method. In most cases, it consists of two coils. One coil is the excitation coil, and the other coil is the sensing coil. The transmitted and received signals are compared and then the signal is plotted as a curve on the screen. Defects are displayed as anomalies in the signals [6]. It is performed using a probe.

3. Methodology

When analyzing work activities, we used work cards as a basis. In the work cards, the maintenance technicians record the working time, the time dedicated to the task they performed. The job card consists of different steps that need to be followed during maintenance. The work card also serves as a procedure for carrying out maintenance, where simple instructions on how to proceed are written on individual points. The individual points on the job card are interconnected and this ensures that all points will be carried out and a high standard of safety is ensured.
In the work sheet for the A320MW OH wheel, the investigation focused on the work time when performing non-destructive testing. Specifically, on the time performance of the penetration method. This method is prescribed when the wheel is overhauled. Then it is necessary to remove the old paint from the wheel. The process of removing the protective and primer coating using sandblasting takes an average of 60 minutes. The overall process of performing the penetration method takes an average of 2.5 hours per piece. The total time required to perform the penetration method is 3.5 hours.
When applying the ultrasound scanning method, the following facts were found. When testing components using the ultrasonic method, thanks to the ability of ultrasonic waves to pass through the material, fewer steps can be performed. By analyzing the procedures, it was found that a total of up to three steps can be omitted. The steps that can be omitted when using the ultrasonic method are sandblasting, the penetration method test itself, which also includes soaking in the penetration medium, taking 45 minutes, and subsequent evaluations and final painting. When painting, it is necessary to apply 2 layers. The first layer is the base layer. The second layer is covering. Depending on the thickness of the varnish, a third layer can also be applied after curing, i.e., a second layer of the varnish covering layer. It is necessary to reserve 60 minutes for the painting itself as a process.

Title	Time [min]
Sandblasting	60
Penetrant method	150
Finishing	60
Ultrasound method	45

It takes 270 minutes to perform the penetration method. If we consider that this time is dedicated to one wheel/component, which is 4.5 hours, then during one work shift the worker can complete 3 wheels/components under ideal conditions.
If these steps were saved and the penetration method was replaced by the ultrasonic method, the time savings would be 3.5 hours per component wheel. At the same time, there would be a shift in working hours, or there would be a place to perform other work. Ultimately, 3 hours of work progress per component would

be achieved in a specialized workshop and this could be transferred to other work activities that would increase work efficiency and speed up the delivery of components to the customer.

4. Discussion

In terms of prevention, maintenance is the primary means of preventing aviation accidents or incidents. Maintenance ensures that the given component is in a state where it is able to ensure operation in all modes and situations that may occur during the operation of the aircraft. Safety in the aviation industry has a high priority. Most accidents are caused by the neglect of the human factor or its overestimation. This is due to the possibility of performing routine work that gives the impression that the work is done correctly. It is therefore necessary to take measures in the maintenance system and its procedures to reduce the risk of overlooking possible damage. When inspecting components with the various methods available, it is also possible to overlook damage or cracks that are present in the component. Thus, some methods could serve as control methods, or replace existing procedures for some non-destructive testing methods. As mentioned earlier, the eddy current or penetration method may not always reveal hidden component defects. Especially if we are talking about the wheel component of the A320MW aircraft, which must meet high safety standards, because the wheels, which are part of the landing gear, are most stressed during take-off and landing, when the aircraft is in critical flight modes. The main problem is that the wheels are not monitored during the flight and therefore neither during landing nor during takeoff. The only sensor that is located on the wheels is the tire pressure sensor, and not all types of aircraft in service are equipped with it. For example, the eddy current method can detect damage on the surface and just below the surface of the part. Thus, this method has its limits and sometimes it is not possible to determine the total depth of component damage. If the wheel is slightly overheated, the result may be distorted due to a possible material change in the place of overheating. However, such a component does not have to be taken out of service, but another type of method would be sufficient, which would either confirm or deny the damage to the component. This would save money for possible scrapping and the part could serve for some time in service.

5. Conclusion

Maintenance in the aviation industry is constantly progressing and it is necessary to improve it and speed up the processes. This results from the requirements of aircraft operators. As we know, maintenance consists not only of repairs, but mainly of inspection and testing of individual parts. The applicability of the ultrasonic method to the aero wheel is possible. The wheel has a smooth surface. In maintenance cases where inspection by penetration method is necessary, it would be possible to replace the penetration method with the ultrasonic method. The ultrasonic method can detect surface and subsurface material damage, even of minimal size. This would save sandblasting the color coating of the wheel, which still corresponds to the operation of the ability. About 2 man-hours would be saved with the ultrasound method. This saving is only on the penetration method. Another 3 man-hours would be saved by sandblasting, i.e. removing the paint and reapplying the colored varnish. The introduction of the ultrasonic method in the workshop for repair and general repair would be appropriate not only in terms of saving time, but also in terms of faster surface checking and less error rate when detecting cracks and damage on the surface or directly inside the material.

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