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Report
ULM IN-012/2017

Incident involving an ELA-07 R-115 aircraft, registration EC-GA5, in Las Rozas (Madrid, Spain) on 16 June 2017

GOBIERNO DE ESPAÑA
MINISTERIO DE FOMENTO

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COMISIÓN DE INVESTIGACIÓN DE ACCIDENTES E INCIDENTES DE AVIACIÓN CIVIL

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COMISIÓN DE INVESTIGACIÓN DE ACCIDENTES E INCIDENTES DE AVIACIÓN CIVIL

Tel.: +34 91 597 89 63
Fax: +34 91 463 55 35

E-mail: ciaiac@fomento.es
http://www.ciaiac.es

C/ Fruela, 6
28011 Madrid (España)

Foreword

This report is a technical document that reflects the point of view of the Civil Aviation Accident and Incident Investigation Commission (CIAIAC) regarding the circumstances of the accident object of the investigation, and its probable causes and consequences.

In accordance with the provisions in Article 5.4.1 of Annex 13 of the International Civil Aviation Convention; and with articles 5.5 of Regulation (UE) nº 996/2010, of the European Parliament and the Council, of 20 October 2010; Article 15 of Law 21/2003 on Air Safety and articles 1., 4. and 21.2 of Regulation 389/1998, this investigation is exclusively of a technical nature, and its objective is the prevention of future civil aviation accidents and incidents by issuing, if necessary, safety recommendations to prevent from their reoccurrence. The investigation is not pointed to establish blame or liability whatsoever, and it's not prejudging the possible decision taken by the judicial authorities. Therefore, and according to above norms and regulations, the investigation was carried out using procedures not necessarily subject to the guarantees and rights usually used for the evidences in a judicial process.

Consequently, any use of this report for purposes other than that of preventing future accidents may lead to erroneous conclusions or interpretations.

This report was originally issued in Spanish. This English translation is provided for information purposes only.

Contents

Abbreviations

°C	Degrees centigrade
AEMET	National Weather Agency
AESA	National Aviation Safety Agency
AG	Autogyro
CIAIAC	Spanish Civil Aviation Accident and Incidents Investigation Commission
g	Grams
gsm	Grams per square meter
h	Hours
HP	Horsepower
Kg	Kilograms
Km	Kilometers
l	Liters
LT	Local time
m	Meters
MAF	Multi-axis fixed wing
METAR	Meteorological aerodrome report
N/A	Not applicable
S/N	Serial number
TULM	Ultralight pilot license
ULM	Powered ultralight aircraft
UTC	Universal Time Coordinated

Synopsis

Operator:	Private
Aircraft:	ELA-07 R-115, registration EC-GA5
Date and time of incident:	16 June 2017 at approx. 19:20 LT[1]
Site of incident:	Las Rozas (Madrid, Spain)
Persons onboard:	1 pilot (uninjured)
Type of flight:	General Aviation - Private
Phase of flight	En route - Cruise
Date of approval:	20 December 2017

Summary of incident:

On Friday, 16 June 2017 at approximately 19:20 local time, an ELA-07 R-115 ultralight autogyro, registration EC-GA5, experienced high vibrations in flight while flying between the aerodromes of Casarrubios del Monte (Toledo) and Robledillo de Mohernando (Guadalajara).

The pilot noticed that upon reducing engine speed, the vibrations decreased. He ruled out making an emergency landing and continued to the destination, as he was able to fly without vibrations if he proceeded at a slightly lower speed than usual. After landing, he saw that two of the three blades in the powered propeller had fissures, and that one of them had a substantial crack near its tip.

The aircraft's sole occupant was uninjured and the aircraft's damage was limited to that found on the two powered propeller blades.

The investigation focused on determining what caused the damage to the blades and on analyzing how the emergency was handled.

1 All times in this report are local unless otherwise specified. On the date of the incident, local time was equal to UTC+2.

The blades were inspected by the manufacturer in France, which concluded that their characteristics had been modified in a way that was not approved by the manufacturer.

The incident was caused by the installation and use of propeller blades that were repaired and modified using procedures not approved by the manufacturer. The modification was also not approved by AESA.

No safety recommendations are issued in addition to those already issued by the CIAIAC involving the prohibition to carry out unauthorized modifications.

1. FACTUAL INFORMATION

1.1. History of the flight

On Friday, 16 June 2017, the owner and sole user of an ELA 07 R-115 ultralight autogyro, registration EC-GA5, was planning to fly solo between the aerodromes of Casarrubios del Monte and Robledillo de Mohernando.

At around 18:30, the pilot proceeded to refuel the aircraft. He did the pre-flight inspection and prepared the aircraft before taking off normally at 19:00 en route to Robledillo de Mohernando, flying the visual corridor of Colmenar Viejo (Madrid), a route that was well known to the pilot.

According to his statement, while over Las Rozas (at approximately 19:20), he diverted from his planned route to the east due to turbulence. After thinking he had left the turbulence behind him, and while attempting to return to the planned route (more to the west), he felt strong (unusual) vibrations in the aircraft as a whole, vibrations that disappeared almost completely if he reduced engine power, and that worsened if he increased engine power. As a result, he decided to continue flying at reduced engine power (and low speed) instead of making an emergency landing. He did not return to the Colmenar Viejo visual corridor, however, instead continuing to the east, flying over El Plantío on a direct route to Robledillo de Mohernando.

At 20:00, he landed in Robledillo without incident. He was then able to confirm visually that two of the three blades on the propeller were damaged: blade #3 had a fissure, while blade #2 had developed a considerable crack.

Figure 1. Aircraft EC-GA5.

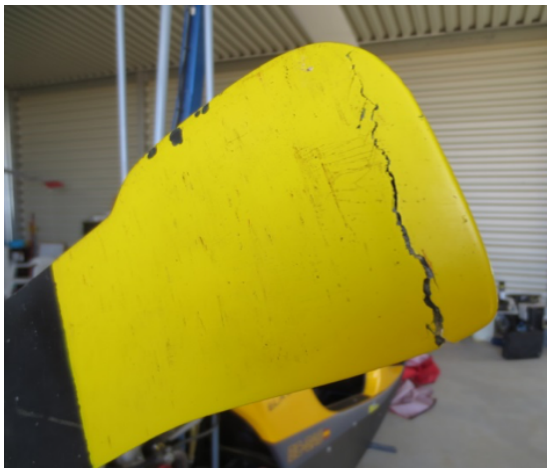

Figure 2. Close-up blade #2

Figure 3. close-up blade #3

1.2. Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft	Others
Fatal				
Serious				
Minor				
None	1		1	
TOTAL	**1**		**1**	

1.3. Damage to aircraft

The damage to the aircraft was confined to the propeller blades.

1.4. Other damage

There was no additional damage.

1.5. Personnel information

The pilot, a 46-year old Spanish national, had an ultralight pilot license (TULM) issued by Spain's National Aviation Safety Agency (AESA) on 14 April 2010, along with autogyro (AG) and multi-axis fixed wing (MAF) ratings, which were valid until 30 April 2018.

He also had a class-2 medical certificate that was valid until 1 April 2018.

According to information provided by the pilot himself, he had a total of 422 flight hours, of which 40 had been on fixed-wing aircraft and 382 on an autogyro (all on ELA-07).

1.6. Aircraft information

The aircraft, registration EC-GA5, was built in 2010 by ELA Aviación S.L., model ELA-07 R-115 and S/N 05102940714. It is an ultralight autogyro with an empty weight of 250 kg and a maximum takeoff weight of 450 kg, with a fixed tricycle gear and two-blade main rotor. It is 5 m long and 2.8 m tall, with a 0.75 m wide fairing.

It is equipped with a 115-HP Rotax 914 UL engine (S/N 6773868) and a three-blade Windspoon propeller, manufactured by DUC Hélices. The blades rotate clockwise as seen from behind the aircraft. The serial numbers of the three blades could not be determined.

The current owner purchased[2] the aircraft in 2010. He was the only person who flew it. At the time of the incident the aircraft had 362 flight hours. Both the engine and the three blades were those originally installed on the aircraft, and they had the same number of flight hours as the aircraft.

The aircraft was registered with the National Aviation Safety Agency on 28 July 2010, and it was issued a special restricted Certificate of Airworthiness by AESA on 23 August 2010.

The aircraft had an insurance policy that was valid until 28 February 2018.

The aircraft was maintained by its owner in accordance with the maintenance manuals recommended by the manufacturers of the aircraft and the engine. The last inspection had been on 1 April 2017, with 325 flight hours on the aircraft. During this inspection (a 50-h check), the owner changed the air, oil and fuel filters, the oil, the antifreeze and the spark plugs. The aircraft had no deferred items at the time of the incident.

The aircraft's total weight during the incident flight was approximately 400 kg, including its empty weight, the pilot's weight and 60 l of fuel.

2 It was purchased directly from the manufacturer by the original and only owner.

1.6.1. Propeller blades

The three Windspoon propeller blades on the engine were manufactured in France by DUC Hélices.

According to the manufacturer, the standard weight of each blade is 1000 ± 20 g. In the manufacturer's weight balance tests conducted on a test bench, the nominal tolerance is given as ± 1 (without units).

During the field inspection of the three incident blades, it was noted that the serial number could not be found on the blades in the location where it should have been. A check with the aircraft manufacturer (ELA Aviación S.L.), which purchased and installed the three blades on EC-GA5, also failed to identify the serial numbers, as it replied that it did not have a record of the blades. The manufacturer was then asked to check the shipping lists for Windspoon blades purchased by ELA from DUC Hélices for the dates when these blades may have been purchased to try to determine the serial numbers. This revealed that the three serial numbers would have been between 7615 and 8435.

The maintenance manual for DUC Windspoon blades specifies[3] three types of maintenance checks to carry out:

- Regular. Must be carried out by the pilot before each flight. This is a visual pre-flight inspection that involves checking (by hand) that the hub and the blades are firmly attached and that the surfaces of the blades do not show any appreciable degradation. According to the pilot's statement, he always did this visual pre-flight inspection, including on the day of the incident, when he noticed nothing out of the ordinary.
- General. May be done by the pilot or by an aviation center every 100 flight hours or annually. It involves a visual inspection of the blades to ensure there is no degradation of the surface. The tightening torque on the blades and their positions is also checked. The pilot stated that this inspection was conducted at the frequency required.
- Complete. Must be done at the facilities of Hélices DUC every 800 flight hours or five years. In the case of the blades on EC-GA5, this overhaul had never been carried out, even though it should have been done in 2015, five years after they were first installed.

3 If installed on a Rotax 914 engine in a pusher configuration.

1.6.2. History of the blades

The propeller blades on aircraft EC-GA5 were, according to the pilot, the same three that were originally installed on the aircraft. Therefore, the blades had the same number of flight hours as the aircraft on the day of the incident, that is, 362.

The pilot stated that on 18 June 2016, with 199 flight hours, while taking off from a dirt field, he heard a small stone impact the aircraft, which immediately started vibrating strangely, so he decided to return to the field and land as soon as possible. When he checked the aircraft, he saw that one of the three propeller blades (he did not recall which, nor did he write it down) had been impacted and exhibited a fissure along the leading edge.

The damaged blade was removed and the pilot and a friend repaired it onsite by applying adhesive and compressing the blade using mechanical jacks for 24 hours, after which the blade was reinstalled on the aircraft. The vibrations did not reappear during subsequent flights of the aircraft.

On 13 August 2016, with 217 flight hours and without having experienced any problems in the 18 flight hours after the repair, the three blades were removed so that a friend of the pilot's could work on them. When asked about the work done, this individual stated that he applied a layer of 200 gsm carbon fiber cloth to the damaged blade (he could not remember which one it was, nor did he record it) with epoxy resin, painted the three blades black and the tips yellow, balanced their weights and returned them to the owner. Since the logo on the blades was no longer visible due to having painted over it, the owner screen printed three DUC Hélices logos similar to what they had before and applied one to each blade.

On 17 September 2016, the owner reinstalled the blades (he had not flown EC-GA5 since removing them, meaning that the aircraft, engine and blades all still had 217 flight hours).

On 16 June 2017, with 362 flight hours, the in-flight incident that is the subject of this investigation occurred. In the pilot's opinion, the vibrations he experienced on the aircraft that day were very similar to those that occurred on 18 June 2016.

1.7. Meteorological information

According to the information provided by the National Weather Agency (AEMET), the weather station at Las Rozas recorded a temperature of 34.5º C and 31% humidity at the time of the incident.

The METARs for the base of Colmenar Viejo (about 20 km northeast) from around the time of the incident were as follows:

METAR LECV 161700Z VRB01KT 9999 FEW050CB FEW060TCU 34/09 Q1022=

METAR LECV 161800Z 31003KT 9999 FEW050CB 32/10 Q1022=

While at Cuatro Vientos (some 15 km south), the METARs were as follows:

METAR LEVS 161700Z VRB01KT 9999 FEW050CB 36/08 Q1019=

METAR LEVS 161730Z VRB01KT 9999 FEW050CB 36/08 Q1019=

METAR LEVS 161800Z 29004KT 250V320 9999 FEW050CB 34/09 Q1020=

Given these data, and based on remote sensing images, there were some convective cloud formations (though with isolated centers), with highly scattered lightning to the north of the area, in the mountains and toward the east, in the Henares Valley. It is possible that there may have been some turbulence in and around Las Rozas associated with convective activity at low levels.

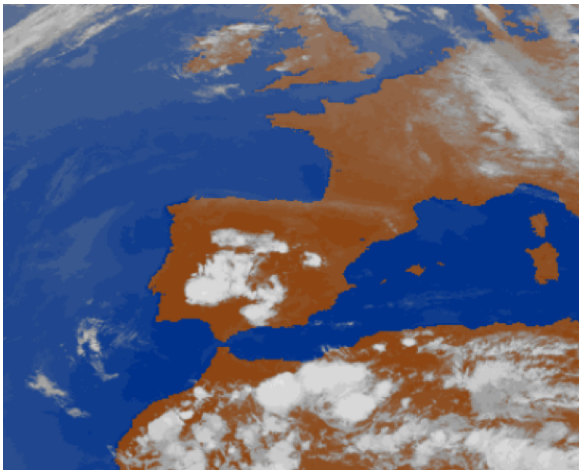

Figure 4. Satellite image (20:00 h).

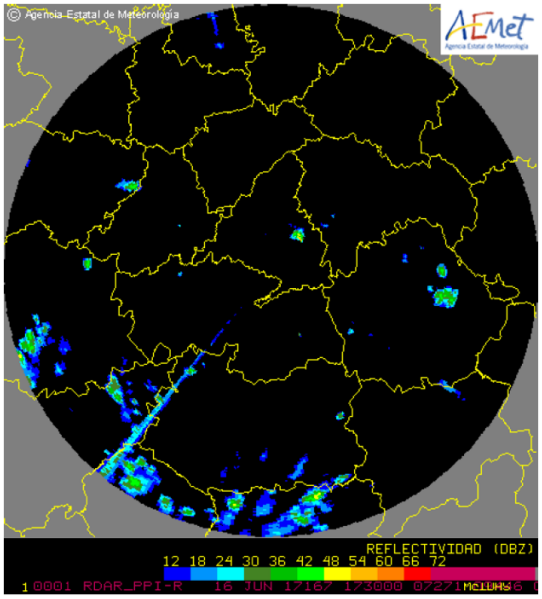

Figure 5. Reflectivity image (19:30 h).

1.8. Aids to navigation

Not applicable.

1.9. Communications

There were no communications or emergency calls.

1.10. Aerodrome information

Not applicable.

1.11. Flight recorders

The aircraft was not equipped with a flight data recorder or a cockpit voice recorder. The aviation regulation in effect does not require this type of aircraft to be equipped with any kind of recorder.

1.12. Wreckage information

After the incident, the aircraft was inspected and found to be in good condition overall. Specifically, the engine and propeller assembly was clean and all of its parts were firmly attached. The blades were properly aligned with their respective notches at the attachment point, which indicate the pitch set.

Blade number 1 exhibited no visible damage, blade 2 showed considerable damage near the tip, parallel to the chord, and blade 3 also showed damage (to a lesser extent) along its leading edge. The figures below show a close-up of the damage to blade 2.

All three blades were sent to the manufacturer in France to be inspected. The findings of this inspection are provided in Section 1.16, Tests and Research.

Figures 6, 7 and 8. Close-up of the damage to blade 2.

1.13. Medical and pathological information

N/A.

1.14. Fire

N/A.

1.15. Survival aspects

The pilot (the aircraft's sole occupant) decided to continue the flight following the vibration event upon realizing that he could reduce the vibrations considerably by lowering the engine speed. The lower airspeed at which he had to fly was also not a drawback.

According to his statement, he was constantly mindful of the possibility of making an emergency landing if the situation worsened.

1.16. Tests and research

1.16.1. Pilot's statement

On 16 June 2017 at about 18:30, I did the pre-flight check of my autogyro, checking all of the inspection items specified by the manufacturer, as I normally do every time I fly. I was cleaning the rotor blades and the propeller blades and I saw nothing out of the ordinary. After adding 40 liters of fuel to the 20 liters of fuel already in the tank, I took off at about 19:00 from the aerodrome of Casarrubios del Monte, en route to the aerodrome of Robledillo de Mohernando, with a total of 60 liters of fuel. There was no copilot.

I knew of the possibility of storms, but I could not see any when I took off. My intention with the planned route was to fly on the Colmenar corridor, but when I reached Las Rozas, strong turbulence forced me to shift to the east. Once everything seemed stable and I tried to return to the route, I felt a very strong vibration, as if the autogyro were entering a resonance mode. I instinctively cut the engine and the aircraft stabilized. Every time I tried to open the throttle, the aircraft got out of control, so I decided to look for a safe place to land, intending to make an emergency landing. I realized that if I maintained a low speed, the vibrations almost went away, so I decided to keep flying at low speed to the aerodrome of Robledillo de Mohernando. Once I landed, at about 20:00, the first thing I did was to look at the propeller, and I saw that two blades on it had fissures.

I had to hangar the aircraft in Robledillo de Mohernando since it seemed dangerous to fly it again.

When asked about his decision to continue the flight once the vibrations appeared, the pilot replied that immediately after the vibrations started, he determined they were identical (or very similar) to those he had experienced in June 2016, when one of the blades fissured. The situation was familiar to him, and he also noticed that if he reduced the engine power, the vibrations almost went away. As a result, he judged the situation to be safe enough to allow him to continue flying. He assumed that the vibrations were from the propeller blades, but he admitted that when he saw the condition of blade #2 after landing, he realized the situation could have been more serious than he first thought, especially if part of the blade had detached while in flight.

1.16.2. Manufacturer's inspection of the blades

The three blades were sent to the DUC factory in France to be inspected. The results of the inspection and of the report issued by the manufacturer are summarized in the points below:

1. The three blades were manufactured by DUC in France.
2. All three blades are of the Windspoon model, but their shape, weight and paint were modified in a way that does not conform to any approved procedure.
3. The blade tips were modified in terms of both their planform and curvature (specifically, it is apparent to the naked eye that the curvature of the tips is practically gone from the blades on EC-GA5). Figures 9 and 10 show a comparison between a blade from EC-GA5 and a production blade.

Figures 9 and 10. Close-up comparison of blade tips on EC-GA5 and a standard blade

4. A crack parallel to the chord so close to the blade tip is very unusual. In this case it may have resulted from weakening of the area after the modification.
5. The three blades were painted black and the tips yellow. The blades that leave the factory are not painted.
6. The DUC logo that was applied to the blades on EC-GA5 is not the factory original; rather, it was a facsimile unlike any of the logos that DUC puts on its blades.
7. On one of the blades, it is apparent that repairs were made to its leading edge, but not to the area where the damage is located on blade 2.
8. The serial numbers of the blades could not be determined since the stickers containing this information had been removed.

Figure 11. Sticker with serial number.

9. The weight and balance of the blades had been considerably modified. A standard blade weighs 1000 ± 20 g, and its balance tolerance is ± 1 g (no units given). The results for the three blades, as determined on a test bench at the factory, are given below:

Blade #	Weight (g)	Balance
1	1084	+43
2	1075	+40
3	1079	+45

As the table shows, both the weights and balances are well in excess of the allowable tolerances.

1.17. Organizational and management information

N/A.

1.18. Additional information

The pilot of the aircraft and his friend (who worked on the propeller blades in the summer of 2016) were repeatedly asked about the changes made to the blade geometry. They consistently replied that they had not modified the geometry of the blades.

In addition, in an effort to ascertain when the blade geometry was modified, investigators asked the pilot for photographs of the aircraft taken between the date

he purchased the aircraft and the date of the incident that showed the blades in sufficient detail. No such photographs were made available.

1.19. Useful or effective investigation techniques

N/A.

2. ANALYSIS

2.1. General aspects

The aircraft's pilot had the flight license and medical certificate needed to make the flight.

The pilot had experience flying the aircraft type, and it was not the first time he experienced vibrations in flight due to damaged propeller blades.

The aircraft had the documentation required to make the flight.

The aircraft had been owned by the same person (the pilot) since being purchased new from the manufacturer. At the time of the incident the aircraft had 362 flight hours, the same number of hours as the engine and the three propeller blades.

With the exception of the three propeller blades (discussed later), the aircraft's overall condition was good. Based on the information provided by the pilot, he maintained it as specified by the manufacturer. There were no deferred items

The weather conditions at the time of the incident flight were not limiting. The pilot had checked the weather on the route and was aware of the possibility of turbulence in the area north of Madrid.

The pilot had also planned the flight with a fuel load that was more than sufficient to make the flight. The aircraft's total weight was below its maximum authorized.

The pilot stated that he did the pre-flight inspection as specified by the manufacturer of the aircraft and of the propeller blades, finding nothing out of the ordinary.

2.2. Propeller blades

The manufacturer of the blades recommends overhauling them at its facilities every 800 hours of operation or every five years, whichever comes first. In this case, said overhaul should have been conducted in 2015 due to the five-year limit, not to the flight-hour limit (362), but it was not.

The two other types of checks recommended by the manufacturer (regular and general) were carried out by the pilot.

Work done on the blades

The history of the three blades was able to be reconstructed based on the pilot's statement, though who modified the geometry of the blades, or when, could not be determined.

In June 2016, a fissure in one of the blades was repaired by hand, not professionally, using a procedure not approved by the manufacturer. The affected blade was not recorded.

In August 2016, the previously repaired blade was again worked on, and all three blades were painted black and their tips yellow. The stickers bearing each blade's serial number were obstructed (or removed, it is not known which), and a logo similar (but not identical) to DUC's was affixed to each blade. None of these actions was approved by the manufacturer.

Inspection of the blades by the manufacturer

The manufacturer's findings involving the three blades are very clear, and summarized as follows:

- The three blades were manufactured by DUC in France, although the serial numbers of the blades could not be determined because the stickers containing them were removed.
- The three blades were painted black and the tips yellow. The blades that leave the factory are not painted. The DUC logo that is attached to the blades on EC-GA5 is not the original from the factory. While it is very similar, it does not match any of the logos that DUC affixes to its blades.
- The three blades are the Windspoon model, but their shape, weight and paint were modified in a way that does not conform to any approved procedure.
- The tips of the blades were modified in terms of both their planform and curvature. A crack parallel to the chord so close to the tip is highly unusual, and may have been caused in this case by a weakening of the area due to the modifications made.
- The changes to the blades' weight and balance after the modifications are clearly unacceptable. The three weights (1084, 1075 and 1079 g) are well in excess of the allowed weight (1000 ± 20 g), as are their balances, whose values of +43, +40 and +45 are far above the allowed value of ±1.

2.3. Handling of the emergency

When the pilot felt the aircraft vibrating abnormally, he quickly associated this event with what had happened in June 2016. His suspicions were confirmed when he verified that the vibrations were directly related with the engine speed, and thought that one of the blades might have developed a fissure.

The fact that he limited the problem to a fissure (and not to a crack) in a blade, his previous experience in a seemingly similar case and the autogyro's ability to make an emergency landing in a small area if necessary, all made him think that the aircraft, even if damaged, could remain airborne for another half hour approximately and continue to the destination.

Although the pilot stated that while flying in degraded conditions he was always mindful of the possibility of making an emergency landing, the fact that he did not land is deemed to have been improper and dangerous. The pilot underestimated the danger of the situation, perhaps influenced by the fact that he thought he knew the source of the vibrations and deemed it unlikely that a fissure could grow into a crack before long.

Since the pilot did not detect anything unusual with the blades during the pre-flight check, and given that a large crack was found in blade #2 after landing, the fissure developed into a crack relatively fast, and the likelihood of part of the blade detaching mid-flight was high. The result of this hypothetical scenario could have been catastrophic, either due to the damage to the aircraft and/or pilot from the detached piece, or to the resulting imbalance in the blades, which would have forced the pilot to land immediately in any location, no matter how unsuitable.

The aircraft user's manual does not consider a generic situation involving abnormal vibrations of the aircraft, or specifically of vibrations in the propeller blades. This is not considered a reason, however, to issue a safety recommendation to the manufacturer, since this scenario by itself is an abnormal flight condition, one that all pilots should, for safety reasons, try to avoid by landing as quickly as possible, as this very pilot did on the same aircraft during the vibration event of June 2016.

2.4. Cause and progression of the incident

The propeller blades that were installed on the aircraft at the time of the incident had originally been DUC Windspoon blades, which were later crudely adapted, resulting in a geometry, weight, balance and surface finish that were very different from the original.

The work done to the blades was clearly inappropriate and had a direct effect on the damage sustained by the blades.

In fact, the area where the crack occurred (so close to the blade tip and parallel to the chord) is an area where such cracks do not typically form due to the low mass[4] between the crack and the blade tip. One possible explanation for this fact is that when the curvature of the blade tip was modified, it weakened the area, which is where the fissure eventually formed and progressed until it grew into a crack.

Blades modified in this fashion have to operate under stress conditions that are very different from their design conditions, not only due to their modified geometry, but to their increased weight, imbalance and altered surface finish. This yields local weakened areas that are neither anticipated or desired, and that can result in fissures that can grow into cracks.

The appearance of vibrations during the incident flight must have been due to a noticeable fissure size (as in the June 2016 case), first in one blade and then the other, or in both at more or less the same time. The fissure would likely not have progressed to the size of the crack that formed in blade #2 had the pilot made an emergency landing as soon as possible.

As a result of the above, this incident is deemed to have been caused by the installation and use of propeller blades that were improperly repaired and modified using procedures not approved by the manufacturer. The modification was also not approved by AESA. The situation was aggravated by the erroneous decision not to make an emergency landing once the vibrations appeared in flight.

4 The tensile stress in the blade structure due to centrifugal force decreases gradually with respect to the distance from the root. The higher the tension, the more stress that builds up in the crack, and the more it grows.

3. CONCLUSIONS

3.1. Findings

- The pilot of the aircraft had the licenses required to make the flight.
- The pilot had experience flying the aircraft type, and it was not the first time he experienced vibrations in flight due to damaged propeller blades.
- The aircraft had the documentation required to make the flight.
- The aircraft had been owned by the same person (the pilot) since being purchased new from the manufacturer. At the time of the incident the aircraft had 362 flight hours, the same number of hours as the engine and the three propeller blades.
- With the exception of the three propeller blades (see below), the aircraft's overall condition was good.
- Based on the information provided by the pilot, he maintained it as specified by the manufacturer. There were no deferred items.
- The weather conditions at the time of the incident were not limiting.
- The pilot had planned the flight properly.
- The pilot stated that he did the pre-flight inspection as specified by the manufacturer of the aircraft and of the propeller blades, finding nothing out of the ordinary.
- The three blades should have been overhauled in 2015 at the manufacturer's facilities, but this was not done.
- The three blades were manufactured by DUC in France, though the serial numbers of the blades could not be determined.
- All three blades are the Windspoon model, but they were modified (in terms of their shape, weight and paint) in a way that does not conform to any approved procedure.
- The blade tips were modified in terms of both their planform and curvature.
- The changes made to the blades' weight and balance following this modification are clearly unacceptable. The new weights and balances greatly exceed the allowed tolerances.

- The changes made to the blades resulted in stresses during flight that are different from the design stresses, with the unexpected and undesired appearance of local areas of decreased strength, which could lead to fissures that can grow into cracks.

- The pilot underestimated the danger of the situation and did not make an emergency landing. His decision to continue the flight is deemed to be improper and dangerous.

3.2. Causes/Contributing factors

The incident was caused by the installation and use of propeller blades that had been improperly repaired and modified using procedures not approved by the manufacturer and a modification not authorized by AESA.

4. SAFETY RECOMMENDATIONS

No safety recommendations are issued in addition to those already issued by the CIAIAC involving the prohibition to make unauthorized modifications.