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COMISIÓN DE
INVESTIGACIÓN
DE ACCIDENTES
E INCIDENTES DE
AVIACIÓN CIVIL

Report
ULM A–010/2014

Accident involving a ULM Moragon M1 aircraft, registration EC-EI3, south of the city of Gijón, Asturias (Spain) on Sunday, 8 June 2014

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MINISTERIO DE FOMENTO

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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
AAE	Asociación de Pilotos de Aviación Experimental (Expimental Aviation Pilots Association)
AEPAL	Asociación Española de Pilotos de Aeronaves Ligeras (Light Aircraft Pilots Spanish Association)
AESA	Agencia Estatal de Seguridad Aérea (Spanish Aviation Safety Agency)
AGL	Above ground level
AOPA	Aircraft Owners and Pilots Association
ATC	Air Traffic Control
ATSB	Australian Transport Safety Board
ft	Feet
hr	Hours
HP	Horse Power
hPa	Hectopascals
In	Inches
Kg	Kilograms
Kt	Knots
l	Liters
m	Meters
METAR	Meteorological Aerodrome Report
MHz	Megahertz
Mm	Millimeters
Mph	Miles per hour
N	North
PPL	Private pilot license
QNH	Altimeter subscale reading to obtain elevation when on the ground
RPM	Revolutions per minute
S	South
s	Seconds
S/N	Serial number
TULM	Ultralight motorized aircraft pilot licence
ULM	Ultralight motorized aircraft

Synopsis

Owner:	Pulgar y Suarez S.L
Operator:	Club deportivo básico Aeroclub La Morgal.
Aircraft:	Moragon M-1, EC-EI3
Date and time of accident:	Sunday, 8 June 2014 at 13:00 local time
Site of accident:	Field southeast of the city of Gijón (Asturias, Spain)
Persons onboard:	2, not injured
Type of flight:	General aviation - Private
Date of approval:	27th of June 2016

Summary of the event:

During a local flight from the La Morgal aerodrome with an estimated duration of 45 minutes and while flying south of Gijón, the engine stopped suddenly while returning to the airfield.

The pilot maintained the ideal glide speed, looked for and selected a field on an uphill gradient in a southwesterly direction for an emergency landing and then unsuccessfully attempted to restart the engine three times.

The left wing of the ultralight impacted a small tree on the edge of the chosen field, causing the aircraft to turn more than 180º left and travel some 30 meters sideways exceeding the original, and then rotating over 180º past the original approach heading. The impact damaged the aircraft's left wing, tore off the right horizontal stabilizer and partially severed the fuselage aft of the cockpit. Neither the pilot nor the passenger suffered any injuries.

The engine failed due to the fracture of a 22-tooth gear attached to the crankshaft and flywheel at the rear of the engine, and which engages with the camshaft, ignition distributor and magnetic flywheel.

The following factors contributed to the accident:

- The faulty and deficient implementation of Jabiru Service Bulletin, JSB 012-2.
- Reusing the 22-tooth gear during this modification.

- Using a propeller different from that specified on the Type Certificate of Airworthiness and that, moreover, was not approved by the engine manufacturer for use on the ultralight.
- The likely weakening of the collapsed component due to mechanical stress during its time in operation.

1. FACTUAL INFORMATION

1.1. History of the flight.

The aircraft was on a local flight from the La Morgal aerodrome that was estimated to last 45 minutes. The pilot stated that both occupants did the pre-flight check, which was satisfactory. They ensured that the fuel level was over half the tank's capacity (35 liters), thus giving them a flying time in excess of 2:30 hours. They also read all the checklists and satisfactorily tested the engine.

They took off from runway 10 at approximately 12:25. They continued on the runway heading at an indicated airspeed of between 80 and 90 mph at a minimum altitude above ground level of 700 ft. The flight was uneventful until they went past the city of Gijón.

The pilot stated that the sky to the north, over the sea, was cloudy and since the wind was from the north, the clouds were approaching, so they decided to return to the aerodrome.

A few minutes after changing course, on straight and level flight at an estimated altitude of 900 ft, 85 mph and 2,700 engine RPMs, engine power dropped suddenly and without warning. The pilot maintained the ideal glide speed (60 mph) while he looked for and selected a suitable place to make an emergency landing. He then tried unsuccessfully to restart the engine three times.

The field chosen for the landing sloped uphill to the southwest. The left wing of the ultralight impacted a small tree on the edge of this field, causing the aircraft to turn more than 180º left and travel some 30 meters sideways exceeding the original approach heading.

Figure 1. Ultralight aircraft after making an emergency landing on the field

The impact damaged the aircraft's left wing, tore off the right horizontal stabilizer and partially severed the fuselage aft of the cockpit. Neither the pilot nor the passenger suffered any injuries.

1.2. Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft	Others
Fatal				
Serious				
Minor				N/A
None	1	1		N/A
TOTAL	1	1		

1.3. Damage to aircraft

The fuselage broke aft of the cockpit. The right stabilizer and elevator broke, the front gear leg was partially broken and the leading edge on the left wing broke and detached. The damage to the aircraft was significant, but the propeller was unaffected.

1.4. Other damage

Several branches broke off on the trees surrounding the field used to make the emergency landing. The grass and surface of the meadow were also damaged as the aircraft traveled over it.

1.5. Personnel information

1.5.1. Pilot

- 54-year old male of Spanish nationality.
- Flight licenses: PPL(A) issued in November 2002, valid until 18 November 2014. TULM issued in February 2005, valid until 15 October 2014.
- Flying experience: 140 airplane hours and 40 ULM hours.

1.5.2. Passenger

The passenger was a 50-year old woman with a valid ULM pilot license (TULM).

1.6. Information on the ultralight aircraft.

1.6.1. General

- Manufacturer: Aeromoragon
- Model: Moragon M-1
- Serial number: M-1-04-022
- Registration: EC-EI3
- Year of construction: 2005
- Owner: Pulgar y Suarez S.L.
- Operator: Club deportivo básico Aeroclub La Morgal.
- Restricted certificate of airworthiness: issued on 11 March 2014 at the La Morgal aerodrome, valid for an unspecified period of time.
- Engines, number/manufacturer and model: one (1) Jabiru, S/N 22A 1366, model No. 2200A firing order 1-3-2-4
- Propeller model: Tonini GT
- Empty weight: 313 Kg
- Maximum takeoff weight: 450 kg
- Airframe hours: 524:55 hours
- Engine hours: 304:20

The datasheet on the Type Certificate of Airworthiness stated that the ultralight was certified to be used with a tractor propeller with three 38-inch long wooden blades with a fixed pitch, and a diameter of 58 inches and made by Batalla. When the ultralight was purchased by the current owner, however, it had a Tonini GT propeller installed.

Spain's National Aviation Safety Agency confirmed that there was no record of the propeller being replaced on this ULM aircraft from the time it was first registered, on 29 April 2005, to the company Asturias desde el Aire S.L.

On 22 November 2012, ownership of the aircraft was transferred to the current owner, Pulgar y Suarez S.L., as recorded on its Certificate of Identification. A year later, on 11 November 2013, the certificate was changed again, with the owner remaining the same but with the aircraft assigned to Club Deportivo Básico Aeroclub La Morgal as the operator of the ULM.

The current owner stated that the Tonini GT propeller was already installed on the ultralight aircraft when it was purchased, and was not replaced or repaired, though the engine-propeller assembly was dynamically balanced.

1.6.2. Maintenance record

The maintenance records for the aircraft and engine were checked to determine the maintenance activities that were conducted:

- In April 2012, with 300 flight hours on the ULM, the engine was overhauled after a failure. During this overhaul, the flywheel was found to be loose, which had damaged and worn the coils on the generator. It was during this overhaul that Service Bulletin JSB 012-2 was implemented, but is was done incorrectly since the 22-tooth gear was improperly machined.
- A 50-hr inspection was conducted in September 2012, with 356 flight hours on the aircraft.
- A new 50-hr inspection was conducted in April 2013, with 403 flight hours on the aircraft.
- Another 50-hr inspection was carried out in August 2013, with 459 flight hours on the aircraft.
- A 500-hr inspection of the aircraft and engine was carried out in March 2014, which included a static balance of the propeller. The airplane's structure was overhauled. The aircraft had 513 flight hours at the time.

1.7. Meteorological information

The pilot stated that when they took off, the ceiling and visibility were unlimited, with the wind from the north (crosswind for takeoff on runway 10) at a speed they estimated at 5 knots. There were no visibility restrictions during the flight and they decided to return to Gijón when they saw cloud formations north of this town and over the sea, which, given the wind direction, they thought could approach their flightpath and even reach the ULM airfield.

The METAR reports for the Asturias Airport between 11:30 and 13:30 were almost unchanged, with variable winds below 4 kt, unlimited visibility, few clouds between 2300 and 2500 ft, temperature between 19 and 20º C, dew point between 10 and 11º C and a QNH, (Atmospheric pressure adjusted to sea level to have the elevation on ground) of 1017 HPa.

1.8. Aids to navigation

Not applicable.

1.9. Communications

The radio frequency assigned to the La Morgal aerodrome is the generic 123.5 MHz frequency. The pilot did not establish radio contact with other aircraft and/or ATC stations other than that made on the aerodrome frequency to coordinate the start of the flight.

When the in-fight emergency occurred due to the engine failure, it was reported on the same frequency, though no one acknowledged receipt.

1.10. Aerodrome information

The La Morgal aerodrome, located in Lugo de Llanera (Asturias), is where the accident ULM was normally based. It was from there that it took off on the local flight that resulted in the accident.

The aerodrome's reference altitude is 180 meters (590 ft). It has a 930-meter long, 30-meter wide asphalt runway in a 10/28 orientation.

1.11. Flight recorders

The ULM did not have any flight recorders, nor were they required to be installed.

1.12. Wreckage and impact information

The pilot selected a field with an uphill gradient for the emergency landing. Since the engine was not driving the propeller, he mistakenly calculated the momentum of the airplane, which impacted the trees surrounding the field before it was able to land. This impact primarily involved the left wing.

Figure 2. Trees and broken branches from the trees surrounding the field, and tracks from the airplane's gear on the ground

A few meters beyond the start of the field there were marks left by the landing gear wheels indicating that the airplane traveled some 30 meters before coming to a stop.

As the airplane traveled over the field, it made a left turn due to the impact by the left wing, eventually making a turn in excess of 180° and ending up almost perpendicular to the original direction of motion, facing to the right of it. The nose wheel leg was also damaged, breaking at the point where the wheel attaches.

The propeller was undamaged, which confirmed that the engine had stopped by the time the aircraft made contact with the ground.

1.13. Medical and pathological information

These aspects are not considered to have played a role in the event.

1.14. Fire

There was no fire.

1.15. Survival aspects

Since the main impact involved the left wing (against the trees) and the landing gear, neither the pilot nor the passenger was exposed to a direct impact in the cockpit, and were able to escape injury.

1.16. Tests and research

1.16.1. Disassembly and inspection of the engine.

The engine on the aircraft was a Jabiru Aircraft Pty Ltd (Jabiru), 4-stroke, air-cooled 2200A engine with four horizontally opposed cylinders. It has a rated power of 80 HP at 3300 RPM. The propeller has a fixed pitch and is mounted directly on the engine crankshaft.

After the engine was removed and disassembled, it was noted that when the engine was started, the propeller plate turned but not the rotors inside the distributor on the ignition system, thus confirming that the engine had failed completely during the accident flight.

It was also noted that none of the cylinder valves moved when the engine turned. This led investigators to discover that the camshaft was not turning, as it had either broken off or otherwise disengaged from the crankshaft.

Figure 3. Flywheel and damaged cone gear

The plate at the rear of the engine supporting the alternator was removed, as was the flywheel and magnetic flywheel assembly, which are attached to the crankshaft by six screws. The 22-tooth cone gear, which transmits the motion of the crankshaft to a 44-tooth gear attached to the camshaft, and which also transmits the rotation to the rotors on the ignition distributors (see Figure 3) was broken.

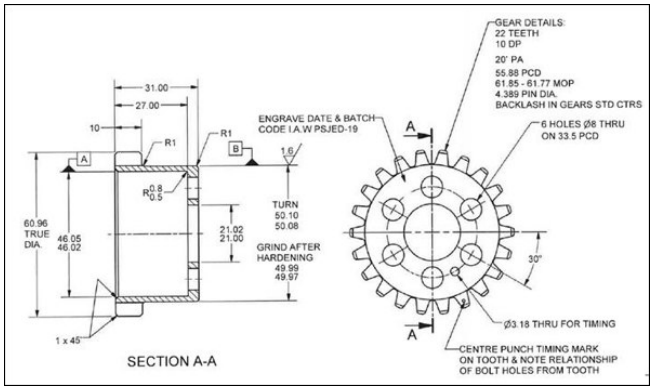
When the cone gear fractured, it caused the crankshaft, the rear halves of the crankcases and the rear plate where the engine is attached to the ultralight to distort. No other abnormalities or damage were found in the engine that could have been related to a possible fault during its operation.

1.16.2. Information exchanged with the engine manufacturer.

The engine manufacturer, Jabiru, was contacted through the Australian Transport Safety Bureau (ATSB). The manufacturer helped establish a link between the engine failure and its possible causes. All of the identifying data for the engine and propeller, along with the fuel type used and the maintenance history of the ultralight and the engine, were given to the manufacturer.

1.16.2.1. Similar in-service failures

The ATSB provided the data it had in its database on in-service failures for this engine, which only contained one case similar to the event in question. On that occasion, two fastening screws on the flywheel were found to have failed when the engine was disassembled, there being no apparent direct connection to the fracture of the 22-tooth gear.



Drawing 1. 22-tooth gear, version used until 2004

1.16.2.2. Analysis of broken gear

The manufacturer confirmed that the component that broke, the 22-tooth gear, was not the part that had been mounted on the original engine on 06/12/2002. These differences can be seen in Drawing 1 and Figure 4. The owner of the ultralight added two holes with a smaller diameter than that on the six 8-mm diameter holes used for the fastening screws on the original part. The owner also replaced the original 3.18-mm diameter timing hole with one of the new holes.

Figure 4. Broken gear installed in the engine

1.16.2.3. Service Bulletin JSB 012

The manufacturer reported that this part was improved in 2004 by adding three new holes for the dowel pins, as shown in one of the new gears in Figure 5. Furthermore, in October 2006 Jabiru issued a Service Bulletin, JSB 012-1, involving the attachment of the flywheel to the crankshaft, and which informed of the possibility of the attachment screws breaking.

This Bulletin states that operating experience has shown that these screws can be affected by the condition and installation of the propeller. The presence of vibrations from the propeller was the main cause given for these in-service faults of the screws.

The flywheels are attached using six screws, which in the first engines in the 2200 series were 1/4" screws, while later engines in that and the 3300 series used 5/16" screws. A subsequent change to the most recent engines resulted in the use of 3/8" screws. The screws were later supplemented with three 6-mm diameter dowel pins, Figure 5.

Figure 5. New replacement gear

The manufacturer states that with the introduction of the 5/16" screws, made so as to solve the in-service problems that had been reported, the tolerance for the thickness of the sidewall on the gear was adjusted. The dowel pins were introduced

later to absorb the twisting force, and the gear wall thickness was increased by 1 millimeter.

In this Bulletin, the manufacturer recommends that all engines be upgraded to the latest specifications, with 5/16" screws and three dowel pins, at the next 2000-hr overhaul. The initial bulletin was republished in June 2011, Issue 2, replacing the first edition.

The manufacturer also stated that the preferred practice is not to drill these new holes for the dowel pins into the existing gear, but rather to replace the gear with the new version when maintenance is done on the engine.

1.16.2.4. Inspection of the propeller outfitted in the accident ULM

On JSB 012, pages 2-3, mentions that there are several conditions leading to flywheel retaining screw failure. These include: excess oil in the flywheel attachment from leaky seals can lead to reduced strength in the connection, propeller strike, abrupt engine stoppage, loss of propeller bolt tension, out-of-balance propellers, damage to the flywheel, loose fitting propeller drive bushes and in particular, the installation of a non-approved propeller.

The propeller installed on the accident ULM prior to being purchased by the current aircraft owner was a Tonini GT, which is not approved by Jabiru because it has not conducted crankshaft vibration testing with this make of propeller, meaning its effects on a Jabiru engine are not known.

1.17. Organizational and management information.

The ultralight aircraft is operated out of the Club Deportivo Básico Aeroclub la Morgal and belongs to Pulgar y Suarez S.L. Personnel from these entities, who appear to be properly trained and use adequate tools and machines, have been performing the maintenance on the engine and aircraft since it was purchased.

When the engine failure led to an overhaul in April 2012, it was these same personnel that carried out the maintenance and implemented Service Bulletin JSB 012. This was done incorrectly since they reused the same gear after making two holes in it through which to insert the dowel pins to attach it to the crankshaft and flywheel.

When the engine was disassembled on that occasion, the screws that fasten the flywheel and the crankshaft were found to be loose. The owner stated that the gear had been inspected and that it looked good.

During this same overhaul, the owner decided not to replace the propeller with one approved by Jabiru.

1.18. Additional information.

1.18.1. Previous accidents of the aircraft.

On 7 September 2013, the ULM Moragon M1, registration EC-EI3, had an accident in Casalinho Pombal (Portugal). The aircraft made an emergency landing due to a malfunction/fault in the flight controls which, according to the pilot, were jammed. The pilot made a successful emergency landing without damaging the ULM.

1.19. Useful or effective investigation techniques

None.

2. ANALYSIS

2.1. General.

The pilot and a passenger, also a pilot, were making a local flight expected to last under an hour and with no special requirements, since the weather was good and they were not performing any aggressive maneuvers.

The pre-flight check and engine test were conducted as required by the school's best practices and by the pilot's awareness of engine problems.

The flight was normal, with the pilot flying in excess of 500 ft AGL at a reasonable speed, above the minimum flight speed and well below the maximum maneuvering speed.

Faced with likely worsening visibility conditions, the pilot started to return to the airfield. A few minutes later, and with no prior indications of any problem, the engine suddenly stopped.

The pilot flew the ULM at the ideal glide speed and started looking for a suitable place to make an off-field landing. He then carried out the emergency procedure to try to restart the engine, but was unsuccessful in doing so.

The pilot selected a field with an uphill gradient and good conditions to make a successful landing. He miscalculated the glide distance, however, and was too low to reach the desired landing location. Instead, the aircraft struck some trees at the edge of the field, which sent the aircraft out of control, causing serious damage to the ultralight but not injuring the occupants.

This type of ultralight flies very well at 50 mph, which offers a safe margin above its stall speed. Due to the long history of engine problems and emergency landings at the flight club, engine failures and steep descents in preparation for a forced or emergency landing are simulated and practiced. This practice includes gliding the aircraft, selecting a suitable landing area, detecting potential obstacles during the descent and flying the ideal trajectory to the landing spot.

2.2. Aircraft and engine.

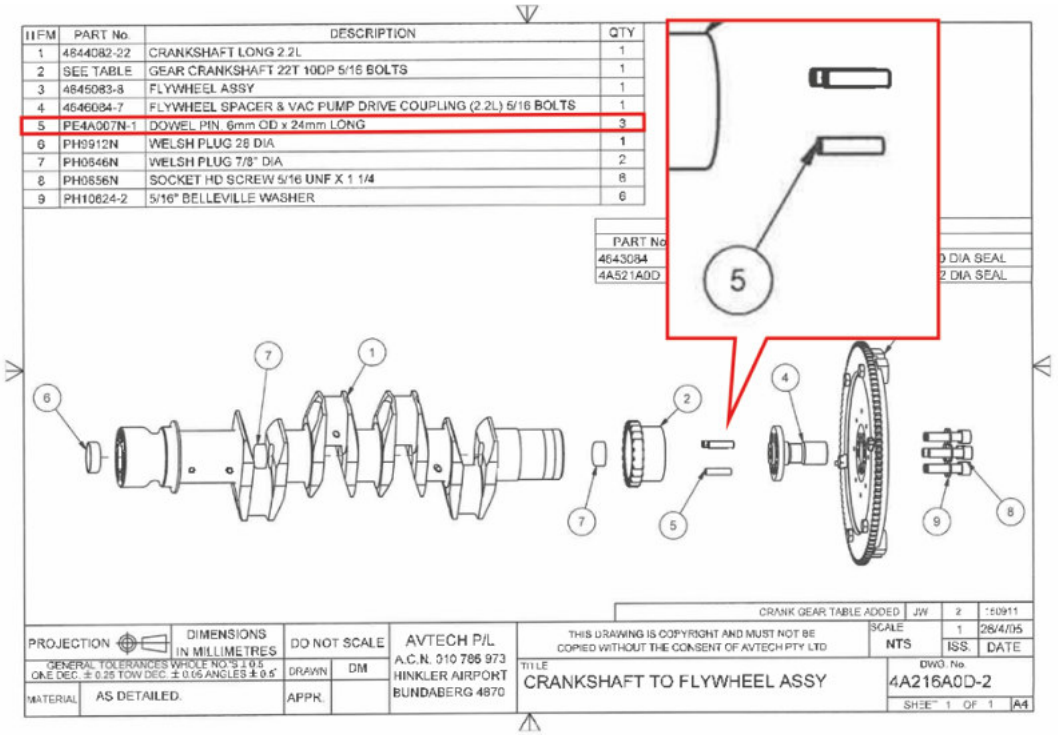
An inspection of the engine revealed the internal failure that caused the sudden stoppage of the engine, since this failure affects the ignition system and stops the motion of the cylinder valves.

The fracture of the vertical wall of the conical gear and the ejection of several pieces of the gearing stopped the rotation of the camshaft and the ignition distributors for all four of the engine's cylinders.

The owner blamed the fracture of the gear on its small wall thickness, since the fracture grew over almost half of its circumference along the rubber seal. This hypothesis could not be confirmed.

By exchanging information with the engine manufacturer, investigators were able to contrast the detail and scope of the work done on the affected gear when Service Bulletin JSB 012 was implemented.

During said implementation, two holes were machined into the gear to enable the installation of the required 6-mm diameter dowel pins. This was done as per the instructions in the diagram for the crankshaft and flywheel assembly included in the manufacturer's Overhaul Manual (see Drawing 2). However, the owner, who machined the gear, misinterpreted the drawing, since both it and the descriptive text mention three dowel pins, as shown in the highlighted parts of the figure. As a result, the owner's modification of the gear was not as required by the Service Bulletin.



Drawing 2. Crankshaft and flywheel assembly, exploded view and description of the components

It should be noted that the applicable regulation, the Order of 14 November 1988, which lays out the airworthiness requirements for Motorized Ultralight Aircraft (ULM), places the responsibility for maintaining the airworthiness of the aircraft on the owner. Said Order does not regulate those individuals or centers that are authorized to carry out the modifications contained in manufacturers' Service Bulletins. In any event, the best option in this case would have been to replace the old gear with one that satisfied the manufacturer's specifications.

As was implied by Jabiru Service Bulletin JSB 012, the manufacturer confirmed that the addition of the three dowel pins to fasten the flywheel to the crankshaft was intended to improve the connection between the flywheel and the crankshaft, and to have the dowel pins absorb the rotational load, with the screws absorbing the fastening loads.

As for the mark left by the rubber seal on the gear, this develops normally as the engine runs and has no effect on the material in the gearing or in the conical gear. The owner's hypothesis regarding the fracture surface can thus be ruled out.

The holes drilled manually into the gear and crankshaft for the dowel pins were not within the tolerance required. The holes for the dowel pins have very exacting requirements if the dowel pin is to fit properly into them while allowing the necessary adjustments, and in all likelihood the manually drilled holes did not allow for said adjustments.

The manufacturer also instructed that these tasks be carried out during the 2000-hour overhaul if the fastening screws do not loosen or break. As a result, these tasks are required to be performed by a Jabiru-authorized engine maintenance facility.

2.3. Summary.

The coexistence of several design, operational and maintenance factors involving the engine caused a weakened component to overload and collapse. Below is a listing and description of the elements involved in the failure scenario, as indicated by the data and information gathered:

- The place where the crankshaft attaches to the flywheel at the rear of the engine had failed during operation, and the manufacturer had redesigned the assembly mechanism, reinforced components and increased the maintenance requirements. This resulted in the manufacturer, Jabiru, issuing Service Bulletin JSB 012-1 and 2 for implementation.

- The owner of the accident aircraft noticed that the engine was in the early failure stages, and decided to implement this Bulletin by modifying the component that was failing, the 22-tooth conical gear, using manual tools after checking its condition. The owner loosened the clearances on the attachment fittings, thereby possibly introducing a source of stress on the machined component, the gear.
- The manufacturer's drawings and instructions were not properly interpreted when the changes and improvements contained in JSB 012-2 were implemented. Two holes were made instead of three and the small timing orifice was replaced.
- The propeller used on this ultralight aircraft, the Tonini GT, is not approved for use by the engine manufacturer, and probably induced high vibrations in the crankshaft that affected the entire rear assembly, as demonstrated by the loose components found during the implementation of the Bulletin. The assembly had, however, been balanced during the last 500-hr inspection, three months before the accident.
- The old gear was reused when implementing JSB 012-2. A new and improved gear, with a greater wall thickness, would have reinforced the assembly.
- The increased diameter of the fastening screws, the introduction of dowels to absorb torsional loads and the increased thickness of the gear wall, trough the Jabiru Service Bulletin 012, all indicate that the point where the flywheel attaches to the crankshaft was a weak point in the engine's design.

3. CONCLUSIONS

3.1. Findings

- The pilot had a valid license and medical certificate.
- The ultralight aircraft was airworthy and had all its documentation in order.
- The accident flight was taking place in good weather conditions. The pilot had planned the flight and it had been properly reported.
- The engine stopped suddenly during the flight.
- The pilot selected a proper location in which to make an emergency landing.
- Before reaching the field selected by the pilot, the aircraft impacted some trees at the edge of the field.
- The initial inspection of the engine showed that the rotors on the distributor for the ignition system and the cylinder valves were not moving with the engine's rotation.
- The teeth on the conical gear joining the crankshaft and the flywheel were completely broken.
- Due to an engine failure, Service Bulletin JSB 012-2 was implemented in April 2012, but it was done so incorrectly.

3.2. Causes/Contributing factors

The engine failed due to the fracture of a 22-tooth gear attached to the crankshaft and flywheel at the rear of the engine, and which engages with the camshaft, ignition distributor and magnetic flywheel.

The following factors contributed to the fracture of the 22-tooth gear and failure of the engine:

- The faulty and deficient implementation of Service Bulletin JSB 012-2.
- Reusing the 22-tooth gear during this modification.
- Using a propeller different from that specified on the Type Certificate of Airworthiness and that, moreover, was not approved by the engine manufacturer for use on an ultralight.
- The resultant exposure of the gear to elevated cyclic stresses during operation.

4. SAFETY RECOMMENDATIONS

REC 51/2016 - It is recommended that AESA inform leading flight schools and potential users of this aircraft assembled in Spain of the harmful effects of installing unapproved engine-propeller assemblies and of carrying out repairs that are not authorized by the manufacturer.

REC 52/2016 - It is recommended that light aviation association AEPAL.- Asociación Española Pilotos Aeronaves Ligeras inform their members of the contents of this report, thus disseminating this information and the lessons learned.

REC 53/2016 - It is recommended that AESA present the findings of this investigation during its professional meetings with light aviation associations so as to reinforce best practices and improve the safety culture in the industry.

REC 69/2016 - It is recommended that light aviation association AOPA.- Aircraft Owners and Pilots Association inform their members of the contents of this report, thus disseminating this information and the lessons learned.

REC 70/2016 - It is recommended that light aviation association AAE.- Asociación Aviación Experimental inform their members of the contents of this report, thus disseminating this information and the lessons learned.