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Report
ULM A-023/2018

Accident involving a powered Avid Flyer ultralight aircraft, registration EC-ZEC, in the vicinity of the aerodrome of Don Benito (Badajoz, SPAIN) on 22 December 2018

GOBIERNO
DE ESPAÑA

MINISTERIO
DE TRANSPORTES, MOVILIDAD
Y AGENDA URBANA

Edita: Centro de Publicaciones
Secretaría General Técnica
Ministerio de Transportes, Movilidad y Agenda Urbana ©

NIPO: 796-20-065-7

Diseño, maquetación e impresión: Centro de Publicaciones

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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

° ' "	Sexagesimal degrees, minutes and seconds
ºC	Degrees centigrade
AEMET	Spain's National Weather Agency
AESA	Spain's National Aviation Safety Agency
FSO	Flight Safety Office
ft	Foot
h	Hour
HP	Horsepower
hPa	Hectopascal
kg	Kilogram
Kg/l	Kilograms per liter
km	Kilometer
km/h	Kilometers per hour
l	Liter
m	Meter
m^2	Square meter
MAF	Multi-axis, fixed wing
mph	Miles per hour
N	North
rpm	Revolutions per minute
TULM	Ultralight pilot license
UTC	Universal Time Coordinated
VFR	Visual flight rules
W	West

Synopsis

Owner and operator:	Private
Aircraft:	Avid Flyer, registration EC-ZEC
Date and time of accident:	Saturday, 22 December 2018 at 13:00[1]
Site of accident:	Vicinity of the aerodrome of Don Benito (Badajoz, Spain)
Persons on board:	1 (uninjured)
Type of flight:	General aviation - Private
Phase of flight:	Landing
Flight rules:	VFR
Date of approval:	29 January 2020

Summary of the investigation

On Saturday, 22 December 2018, an Avid Flyer powered ultralight, registration EC-ZEC, made an emergency off-field landing 2.5 km north of the town of Don Benito (Badajoz, Spain).

The pilot was on a local flight, from and to the aerodrome of Almendralejo (Badajoz, Spain) when, according to information provided by the pilot, the engine on the aircraft started to behave erratically, with the RPMs dropping and the engine failing to provide the power needed to continue flying and eventually stopping. As a result, he decided to make an emergency landing in a crop field.

The pilot was not injured and he exited the aircraft by his own means. The aircraft sustained significant damage to its landing gear, fuselage, blades and wings.

The investigation has determined that one of the aircraft's two carburetors stopped working, and as a result stopped supplying fuel to its two connected cylinders. Moreover, the two cylinders that were operational were flooded due to the maximum power that was being demanded when the other two cylinders stopped working.

An inspection of the engine and its auxiliary components also revealed that the engine had not been maintained as specified by the manufacturer.

[1] All times in this report are local. To obtain UTC, subtract 1 hour from local time.

The accident was caused by the execution of an emergency off-field landing on a fairly irregular field due to the in-flight loss of engine power.

1. FACTUAL INFORMATION

1.1. History of the flight

On Saturday, 22 December 2018, an Avid Flyer powered ultralight, registration EC-ZEC, made an emergency off-field landing 2.5 km north of the town of Don Benito.

According to information provided by the pilot, he was on a local flight to and from the aerodrome of Almendralejo. He had planned to fly to the aerodrome of Don Benito, fly over it and return to Almendralejo. It was while flying at a low elevation over the runway at the aerodrome of Don Benito that, as he commanded power to climb and gain altitude, the engine started to behave erratically, with the RPMs dropping and the engine failing to provide the power needed to continue flying.

According to his statement, he initially thought he could make a 180º turn and land via the threshold he had just flown over, but he thought it unsafe, so he ruled out this idea. He decided to try to fly the circuit pattern to the north of the airfield and land in the other direction. While on the downwind leg, upon seeing that the altitude and speed were insufficient to complete the circuit pattern, and that the engine was providing practically no power, he decided to make an emergency landing on a crop field. Before landing, the engine stopped working altogether.

He configured the aircraft with landing flaps and flared at the lowest speed possible without losing control (about 40 mph), keeping the nose up in order to touch down with the main gear first. Because the ground was soft, the left landing gear leg collapsed and the airplane came down on the nose wheel, which gave way, causing the entire aircraft to yaw left and come to a stop in just 8 meters.

The pilot was not injured and he exited the aircraft by his own means. The aircraft sustained significant damage to its landing gear, fuselage, blades and wings.

Figs. 1 and 2: Views from the left rear and right front of the aircraft after the accident

1.2. Injuries to persons

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

1.3. Damage to aircraft

The aircraft sustained significant damage that affected the landing gear, fuselage, blades and wings (especially the left wingtip and the junction of both half wings with the fuselage).

Fig. 3: View from the right rear of the aircraft after the accident

1.4. Other damage

Not applicable.

1.5. Personnel information

The pilot, a 58-year-old Spanish national, had an ultralight pilot license (TULM) issued by the National Aviation Safety Agency (AESA) on 17 February 2017, with a multi-axis fixed-wing (MAF) rating that was valid until 28 February 2019. He also had a class-2 medical certificate that was valid until 4 January 2019.

He had a total of 68:17 flight hours, of which 19:42 had been on the same type as the accident aircraft (he had flown it exclusively since 6 May 2018).

He was the owner of the accident aircraft.

1.6. Aircraft information

The Avid Flyer ultralight, registration EC-ZEC, is a single-engine, high-wing, amateur-built aircraft with a tricycle gear that was built in 2001. It had serial number 42/90. It has an 80-HP ROTAX 912 ULS engine, serial number 3792546, manufactured in 1989, and a fixed-pitch, two-blade propeller.

Its general characteristics are as follows:

- Wingspan: 9.12 m
- Length: 5.20 m
- Height: 1.80 m
- Wing surface: 9 m^2
- Empty weight: 262 kg
- Maximum takeoff weight: 450 kg
- Fuel capacity: 53 l in each wing plus 8 l in the auxiliary tank they flow into.Total of 114 l
- Stall speed with flaps extended and one occupant: 33 mph

Its registration certificate from Spain's Civil Aviation General Directorate dates from 14 August 2001.

It had a Special Restricted Certificate of Airworthiness, category PRIVATE-3-Normal, first issued by the Civil Aviation General Directorate in December 2001. After being renewed twice, the certificate of airworthiness was allowed to expire from 24 November 2007 until 27 November 2017 (10 years). It was then renewed until 26 November 2019. The validation seal on the renewed Certificate of Airworthiness is from AESA Flight Safety Office #5, at the Bilbao Airport.

It also had a maintenance program that was approved on 24 November 2017 by AESA Flight Safety Office #6, at the Cuatro Vientos Airport. The approval has two signatures (the director's and the inspector's, both from FSO #6), sealed with two different stamps, one for AESA FSO #6 at the Cuatro Vientos Airport, and the other is a stamp for the old Flight Safety Department #6 of the Civil Aviation General Directorate at the Cuatro Vientos Airport.

The pilot (current owner) purchased the aircraft in March 2018. At the moment of purchase, he was given logbooks for both the aircraft and the engine. As concerns the

former, the only maintenance entry was signed by the previous owner and shows that on 30 August 2017, it had undergone a type-C[2] check with 600 flight hours. The aircraft logbook had no flight entries. This logbook was issued on 14 August 2001, with the stamp from Flight Safety Department #6 of the Civil Aviation General Directorate at the Cuatro Vientos Airport.

As for the engine logbook, it was issued on 27 November 2017 and bore the seal of AESA Flight Safety Office #5, at the Bilbao Airport. This logbook is blank and only specifies the number of engine hours, which is 500, and that the engine has to be overhauled every 200 h and undergo a periodic check every 50 h.

The aircraft's new owner replaced the gascolator with a new one and installed an electric fuel pump. Four flight hours before the accident, he had changed the oil and filter, and all the spark plugs.

Prior to the accident, the aircraft flew an additional 19:42 h, all with the new owner since the purchase.

1.6.1. Aircraft weight on the accident flight

After the accident, 45 l were drained from the tanks, plus the 8 l from the auxiliary tank. Assuming a density of 0.72 kg/l for 95-octane unleaded gasoline, the 53 l of fuel weigh 38 kg.

The total aircraft weight would be as follows:

- Empty weight:	262 kg
- Pilot:	80 kg
- Fuel:	38 kg
Total	380 kg

The aircraft's weight at the time of the accident would thus be within the limits specified by the manufacturer.

1.7. Meteorological information

AEMET has an automated station in Don Benito, about 2.5 km south from the accident site. On the day of the accident, at 13:00, the reported conditions were as follows: average windspeed of 6 km/h from the northeast, gusting to 14 km/h, temperature of 10º C, relative humidity of 87% and pressure of 1004 hPa.

[2] A type-C check is a 200-h/24-month inspection.

1.8. Aids to navigation

Not applicable.

1.9. Communications

Not applicable.

1.10. Aerodrome information

The aerodrome of Don Benito is some 2.5 km north of the town by the same name. Its coordinates (WGS-84) at the reference point are 38º 58' 42" N - 5º 51' 58" W, and the airfield elevation is 250 m (820 ft).

It has a compacted soil runway in a 09/27 orientation that is 700 m long.

1.11. Flight recorders

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

1.12. Wreckage and impact information

The accident occurred some 320 m northwest of the runway 09 threshold, at coordinates 38º 58' 43.74" N - 5º 52' 26.49" W.

The pilot made the emergency landing at the lowest speed possible while still maintaining control of the aircraft in order to minimize its energy. The main landing gear made contact with the ground first (slightly earlier with the left wheel), but the soft terrain made the wheel sink, and the left and nose wheels collapsed upon touching down. The marks made (see Fig. 1) were about 4 m long.

The aircraft wreckage was resting on the ground on the front left part of the fuselage. The fractures exhibited by the blades indicate that the engine was not running at the time of landing.

The fuel tanks and lines maintained their structural integrity and no fuel leaked out.

1.13. Medical and pathological information

Not applicable.

1.14. Fire

There was no fire.

1.15. Survival aspects

The cockpit compartment was not deformed and the pilot was wearing his seatbelt during the landing.

The aircraft also landed at a very slow speed in a level attitude. The aircraft's energy was dissipated when the left main landing gear and the nose gear collapsed in the muddy ground, causing the aircraft to stop in just a few meters.

The pilot was uninjured and exited the aircraft by his own means without any problems.

1.16. Tests and research

1.16.1. Pilot's statement

The accident flight was going to be a local flight from the aerodrome of Almendralejo, the idea being to go to Don Benito, fly over its aerodrome and fly back.

Based on his statement, the flight path before the accident has been reconstructed in Fig. 4, showing the significant points that correspond to his description of the event.

Upon reaching the aerodrome of Don Benito, he flew over runway 09 (point 1 in the figure) toward the east (he estimates his altitude over the runway was 400-500 ft, and his speed about 65 mph). As he flew over the 27 threshold, he applied power (point 2 in the figure) to the engine to climb and accelerate. It was then that the engine started to misfire, staying below 3000 RPM with sharp oscillations below that value.

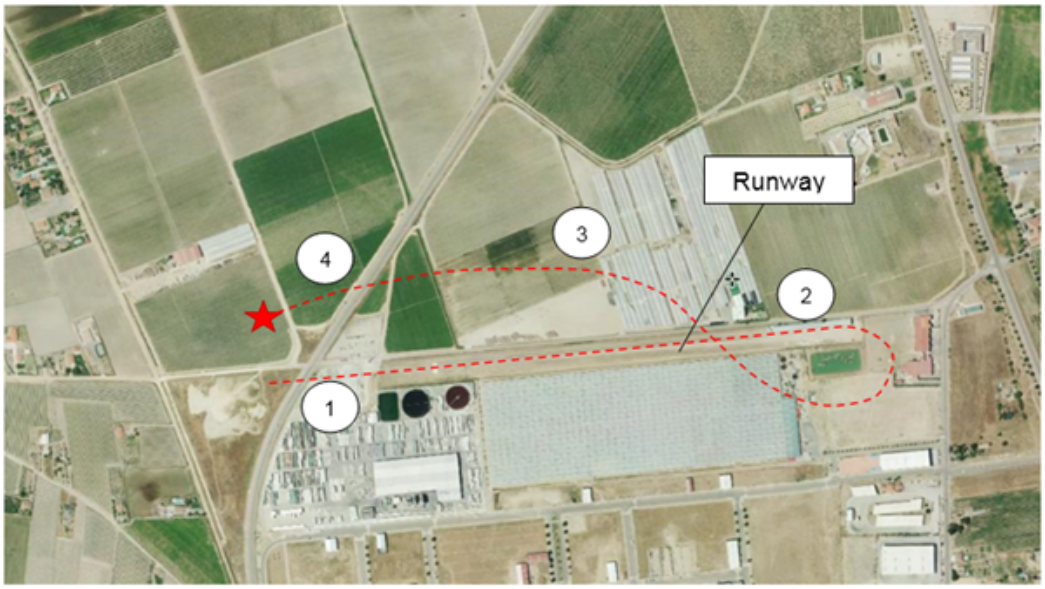

Fig. 4: Relative locations of aerodrome, flight path and accident site

When asked about the wind, he stated that it was at about 8-10 km/h from the east.

Initially he thought he could land via the threshold he had just overflown (27) and he began a right turn to spiral and lose altitude. However, seeing how sharply he would have to turn, he changed his mind and decided to land on runway 09. He thus continued with the right turn (wider), flying over the runway and joining the downwind leg north of the runway (point 3 in the figure). Once he had the 09 threshold to his left, he noticed a large embankment between the airfield and his position, atop which was a road and two truck parking lots. His altitude above the ground had fallen to about 150 ft, and he maintained a speed of between 60 and 65 mph. The engine then stopped completely (point 4 in the figure) and, seeing that below him was a fallow field, he decided to land on it. He set landing flaps, flared at a very low speed (about 40 mph) and kept the nose up in order to touch down with the main gear first.

During the landing, the left main gear leg collapsed due to the soft ground, and the airplane came down on the nose wheel, which gave way, causing the aircraft to yaw left.

He was able to exit the airplane by his own means, uninjured.

1.17. Organizational and management information

Not applicable.

1.18. Additional information

Not applicable.

1.19. Useful or effective investigation techniques

1.19.1. Field inspection

The field investigation focused on finding the cause (or causes) of why the engine stopped supplying power and stopped.

Having ruled out fuel starvation, the tanks were verified not to contain traces of water, although there were impurities in the auxiliary tank. There was also a considerable amount of impurities at the bottom of the gascolator, but no water.

The battery was connected to check the operation of the electric pump, which worked, supplying fuel to the carburetors. Both carburetors had fuel in their pans, at the bottom of which investigators found metal particles.

The integrity of both carburetors was verified to be satisfactory, although they were poorly maintained overall and the material was worn.

The spark plugs were removed, revealing that:

- The left-side spark plugs[3] (cylinders 2 and 4) indicated a lean mixture, whitish color.
- The right-hand spark plugs (cylinders 1 and 3) indicated a rich mixture, with traces of soot.

It was determined that cylinders 1 and 3 had been receiving more fuel, although the cause was unknown.

The air intake system did not exhibit any abnormalities indicative of improper operation. The two air filters were inspected and found to be in normal condition.

The engine was energized, and by using the electric starter motor, the investigators verified that:

- The spark plugs were firing
- The magnetos worked correctly
- Engine compression was correct in all four cylinders
- The engine was not seized

The mechanical fuel pump was inspected and found to be a very old model (made by Pierburg) that is no longer in use. In fact, the mechanical fuel pumps that Rotax has been installing for a few years have a service life of 5 years, and this one could easily have been over 20 or 25 years old (the engine had been manufactured 29 years earlier, in 1989). Both parts of the pump, before and after the filter, were dirty and had particles that should not have been there. The filter, shaped like a flat disk, had gaps that fuel could flow through without being filtered.

As for the oil filter, it was not the same brand that is installed by Rotax, but it was compatible. It had been installed for just 4 flight hours, and when it was opened, the oil inside it was found to contain no metallic impurities. The filter paper inside it was pressed and opened and it did not contain metallic impurities.

The original rubber hoses in the supply line from the mechanical fuel pump to the T-shaped connector leading to the carburetors was in poor condition. They were clearly worn, with very noticeable bubbles and deformations.

[3] As seen from the cockpit.

Fig. 5: Fuel hoses in poor condition

Regarding the carburetors, before removing them, it was decided to run the engine on the test bench with them installed to check their operation.

1.19.2. Engine bench test

The engine was taken to a workshop specializing in this type of engine for testing. The results were as follows:

Preliminary considerations

To run the test, the oil and fuel filters were installed, along with a new fuel pump. The two carburetors were the original units from the accident engine (which were in the same condition they were in after the accident and had not been disassembled earlier, save for the pans to see if they contained impurities). The original fuel hoses were also replaced with new ones.

The entire ignition system was the same as on the accident flight.

The result of the engine bench test was as follows:

The engine started without major problems; however, in just a few seconds, it started to behave very erratically, with large vibrations and a sound that indicated it was not running properly. It did not go above 2500-2600 RPM, and if it was lowered manually below 2000 RPM, it stopped. The oil and fuel pressures were good, however.

The entire ignition system was verified to be working. The spark plugs were firing and the caps were correctly installed, based on the diagram for the ignition box. The compression in each cylinder was checked and verified to be correct in all four.

The exhaust manifolds for cylinders 2 and 4 (located on the left as seen from the cockpit) were almost cold and could be touched by hand without burning, while the other two were hot. This seemed to indicate that cylinders 2 and 4 were not working.

The two carburetors were swapped to see if they had any effect on the temperatures.

The engine was re-started and it ran practically the same as the first time in terms of the noise, vibrations and RPM.

The engine was stopped and cylinders 1 and 3 were verified not to be working now, opposite from before. The problem was thus isolated to the carburetor that was originally supplying cylinders 2 and 4.

The float bowl was removed from the carburetor in question and found empty (which in and of itself explains why the carburetor was not supplying fuel to its cylinders). For some reason, fuel was not going into the float bowl. In addition, large metallic impurities were also found at the bottom of the bowl (see Figure 6).

Fig. 6: Metallic impurities in the float bowl of the carburetor for cylinders 2 and 4

Since there was no fuel, the float valves were at the bottom and the float valve lever was down (it was not seized in the up position), meaning it was demanding fuel but it was not being supplied. Therefore, having ruled out the float valve lever being stuck in the up position, it was decided to check what was happening at the fuel inlet to the float bowl.

The moving parts of the carburetor were disassembled and it was discovered that the fuel intake valve was blocked by impurities that were visible to the naked eye and that kept fuel from entering the float bowl.

The source of these metallic impurities was determined to be the area of the intake screw, which seals the entrance of the carburetor fuel hose to the valve. Without

removing the screw, compressed air was used to blow through the line in the direction of fuel flow. This pushed the impurities onto a piece of white blotting paper. Right away, and without waiting for the paper to dry, it was possible to see the impurities that where flowing into the carburetor float bowl during operation.

The screw in question was removed and it and its housing were inspected in detail. The female thread on the housing for this screw was found to be in very poor condition, and the metal chips that had detached from this thread corresponded to the impurities found.

In fact, a comparison of the female threads on both carburetors showed that in the problematic carburetor, the screw went into its housing for several millimeters without being threaded in due to the number of crests that were missing in the female thread. In the other carburetor, the screw did not go in unless it was screwed in, since the thread was in good condition.

Once the affected area of the carburetor was cleaned, it was reassembled and reinstalled in the engine, which started normally and ran perfectly, with no vibrations or strange noises and able to reach 4500 RPM without any problem.

The engine failure was determined to have been caused by the following sequence of events:

First, the blockage of the fuel intake valve prevented fuel from flowing into the float bowl of the carburetor that supplies cylinders 2 and 4, as a result of which said cylinders stopped working. This blockage occurred when the pilot opened the throttle to climb, since the engine had not exhibited any signs of malfunctioning before then. This explains the pilot's statement that the engine started to misfire and that the RPM did not climb above 3000.

Even though the pilot immediately turned on the electric fuel pump, this did not yield any improvements in the operation of the engine. This is perfectly logical since the use of this pump provides (ensures) adequate fuel pressure, which was already being provided by the mechanical pump, a malfunction of which was ruled out.

Secondly, the two cylinders that were working flooded due to the maximum power that was commanded when the other two cylinders stopped working. This is consistent with the condition of the spark plugs after the accident, with the ones on the working cylinders (1 and 3) showing a rich mixture, with traces of soot, and the spark plugs on the malfunctioning cylinders (2 and 4) showing a lean mixture with a chalky color.

2. ANALYSIS

The aircraft's maintenance records were certainly scant and practically unsupported by any documentary evidence. Moreover, in the opinion of the specialist on Rotax engines during the inspection of the engine, it was clear, even to the naked eye, that the engine was very poorly maintained. It had parts that seemed to be very old, and even worn (such as the fuel lines and other plastic components).

Rotax currently recommends that the mechanical fuel pump be replaced every 5 years. The one installed on this engine, however, was already discontinued and it was, in the opinion of the expert mechanic, as old as the engine, that is to say, about 29 years old.

It may be concluded that the engine had not been maintained as specified by the manufacturer.

And yet, after ten years during which the Certificate of Airworthiness had lapsed (meaning that the airplane presumably was not flown), the aircraft was again certified as airworthy when it clearly was not.

Engine failure

The investigation determined that the carburetor that supplied fuel to cylinders 2 and 4 stopped working[4] due to a blockage of the fuel intake valve that prevented fuel from entering the carburetor float bowl, which stopped cylinders 2 and 4. This blockage resulted from the highly deficient status of the female thread on the intake screw that seals the entrance between the carburetor fuel line and the valve. It was determined that the metal chips that blocked the fuel intake were of the same material as the poorly maintained female thread.

A maintenance inspection of the carburetor would have revealed the problem with the screw thread immediately.

Emergency landing maneuver

The pilot stated that he made the final approach for the emergency landing at about 40 mph, meaning there was still some margin over the 33-mph stall speed, according to the aircraft flight manual for a flaps-down configuration with one occupant on board.

In light of the marks left on the ground, the aircraft is believed to have made a two-point landing at a low speed. The collapse of the left and nose legs resulted in the aircraft dissipating its energy over a very short distance.

[4] At that point, the pilot commanded maximum power to climb and gain speed.

Given the low power supplied by the engine (which stopped before the landing), the pilot's decision to make an emergency landing in the field where he did is deemed correct, since he did not have much room for maneuver. The landing itself is also deemed to have been correct, executed at a low speed without stalling, with the wings level, nose up and the pilot properly restrained by the seatbelt.

3. CONCLUSIONS

3.1. Findings

- The pilot of the aircraft had the necessary flying license and medical certificate for the flight.
- The pilot was the owner of the aircraft and had 19:42 flight hours on the type (all on the accident aircraft itself), and a total of 68:17 flight hours.
- The aircraft had the necessary permits for the flight.
- The last time the Certificate of Airworthiness was renewed was on 27 November 2017, making it valid until 26 November 2019. The validation seal on the renewed Certificate of Airworthiness is from AESA Flight Safety Office #5, at the Bilbao Airport. Before then, the aircraft had gone ten years without a valid certificate.
- Regarding the last scheduled maintenance inspection, there is an entry in the aircraft logbook signed by the previous owner stating that on 30 August 2017, a type-C inspection (200 h/24 months) had been performed with 600 flight hours.
- In March 2018, the pilot replaced the gascolator with a new one and installed an electric fuel pump. Four hours before the accident he had also changed the oil and filter, as well as all the spark plugs.
- No flights were entered in the aircraft logbook.
- The engine logbook was issued on 27 November 2017, with the seal of AESA Flight Safety Office #5, at the Bilbao Airport. This logbook is blank and only specifies the number of engine hours, which is 500, and that the engine has to be overhauled every 200 h and undergo a periodic check every 50 h.
- The weather conditions at the time of the flight were not limiting.
- The aircraft had 53 l of fuel at the time of the accident.
- The load and balance of the accident aircraft were within the manufacturer's limits.
- During the flight, the carburetor that supplied fuel to cylinders 2 and 4 stopped working when the fuel intake valve was clogged, which prevented fuel from entering the carburetor float bowl and stopped cylinders 2 and 4.
- The aircraft landed with the engine stopped.
- The pilot decided to make an emergency landing in a field that, despite being large and flat, was covered in mud and had sizeable sections of plowed terrain.
- The left and nose landing gear legs collapsed upon touching down.
- The landing occurred in low-energy conditions.

- The pilot's seatbelt was fastened at the time of the accident.

3.2. Causes/Contributing factors

The accident was caused by the execution of an emergency off-field landing on a fairly irregular field due to the in-flight loss of engine power.

4. SAFETY RECOMMENDATIONS

None.