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Report
ULM A-007/2017

Accident involving an ICP SAVANNAH ULM aircraft, registration EC-ES1, in the vicinity of the Sant Feliú de Buixalleu restricted aerodrome (Girona, Spain) on 9 April 2017

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MINISTERIO DE FOMENTO

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SUBSECRETARÍA
COMISIÓN DE INVESTIGACIÓN DE ACCIDENTES E INCIDENTES DE AVIACIÓN CIVIL

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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.

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Abbreviations

° ' "	Sexagesimal degrees, minutes and seconds
° C	Degrees centigrade
AEMET	National Weather Agency
AESA	National Aviation Safety Agency
cm	Centimeters
cm^3	Cubic centimeters
g	Acceleration due to gravity
h	Hours
hPa	Hectopascals
kg	Kilograms
kg/dm^3	Kilograms/cubic decimeter
km	Kilometers
km/h	Kilometers/hour
kW	Kilowatts
m/s	Meters/second
m^2	Square meters
MAF	Multi-axis fixed-wing rating
m	Meters
mm	Millimeters
N	North
N/A	Not affected
NE	Northeast
NW	Northwest
RPM	Revolutions per minute
s	Seconds
s/n	Serial number
SE	Southeast
TULM	Ultralight pilot license
ULM	Ultralight
UTC	Coordinated universal time
V_A	Maneuvering speed
V_{FE}	Maximum flap extended speed
V_{NE}	Never exceed speed
W	West

Synopsis

Owner and Operator:	Private
Aircraft:	ICP Savannah, registration EC-ES1
Date and time of accident:	Sunday, 9 April 2017 at 17:35
Site of accident:	Vicinity of the Sant Feliú de Buixalleu restricted aerodrome (Girona, Spain)
Persons onboard:	2, 1 pilot & 1 passenger. Both seriously injured
Type of flight:	General aviation - Private
Phase of flight:	Approach
Date of approval:	29 November 2017

Summary of event:

The aircraft, with the pilot and one passenger onboard, had taken off from the Moia aerodrome (Barcelona) to start the return flight to the Sant Feliú de Buixalleu aerodrome (Girona), from which it had taken off that same day at 13:30.

As the aircraft was approaching runway 13 at the Sant Feliú de Buixalleu aerodrome, the engine stopped. The aircraft started descending immediately, which caused it to impact the tops of some of the trees that covered the area being overflown. The aircraft eventually crashed to the ground in a forest in a nearly vertical position.

The occupants were able to report the accident to the manager at the Sant Feliú de Buixalleu aerodrome by telephone.

Both the pilot and passenger were seriously injured and the aircraft sustained heavy damage.

The investigation has determined that this accident was caused by the engine stoppage during the approach to the Sant Feliú de Buixalleu aerodrome (Girona), probably due to an excessive input made by the pilot to the engine lever when attempting to place it in idle.

The following factors contributed to this event:

- Flying the approach too slowly and too close to the ground.
- The pilot's incorrect assessment of the height, which caused him to reduce engine power prematurely.
- The effects caused by the topography and by the ground friction effect on the wind during the approach.

1. FACTUAL INFORMATION

1.1. History of the flight

At 13:30 on 19 April 2017, the aircraft, with the pilot and one passenger onboard, took off from the Sant Feliú de Buixalleu aerodrome (Girona) en route to the Moia aerodrome (Barcelona), where it landed a short time later.

Early in the afternoon, after having lunch, they took off from Moia to return to the aerodrome from which they had departed.

As the aircraft was approaching runway 13 at the Sant Feliú de Buixalleu aerodrome, the engine stopped. The aircraft started descending immediately, which caused it to impact the tops of some of the trees that covered the area being overflown. The aircraft eventually crashed to the ground in a forest in a nearly vertical position

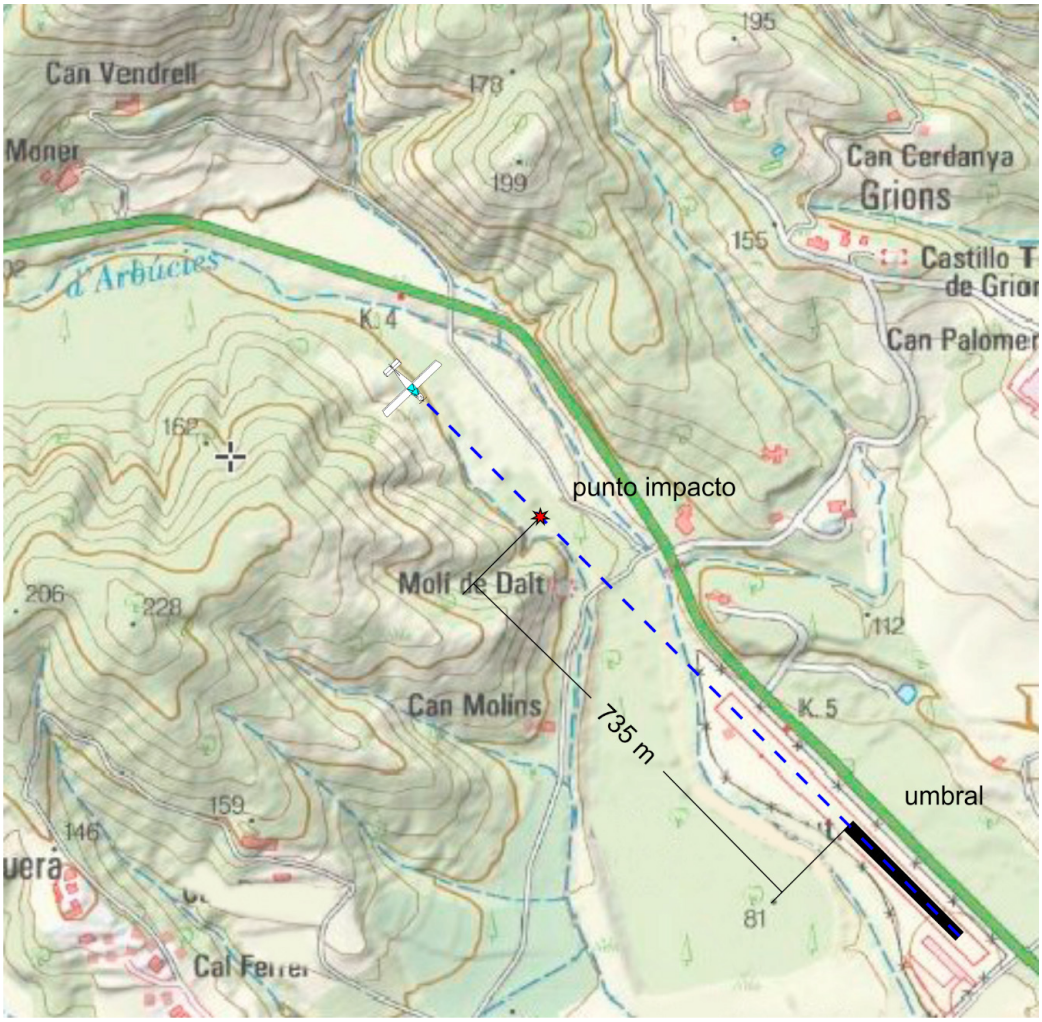

Figure 1. Map of the crash site, showing the point of impact and the Sant Feliú de Buixalleu aerodrome

The occupants were able to report the accident to the manager at the Sant Feliú de Buixalleu aerodrome by telephone.

Emergency services reported to the crash site quickly and proceeded to evacuate the two aircraft occupants to a hospital.

1.2. Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft	Others
Fatal				
Serious	1	1	2	
Minor				N/A
None				N/A
TOTAL	1	1	2	

1.3. Damage to aircraft

The aircraft sustained significant damage as a result of the impacts against the trees and terrain, primarily in the following areas:

- Engine and propeller.
- Nose leg.
- Cabin.
- Both wings, with multiple bends and fractures due to the impacts with the trees.
- Fuselage.

1.4. Other damage

There was no other damage.

1.5. Personnel information

The pilot, a 48-year old Spanish national, had an ultralight pilot license (TULM) initially issued by Spain's National Aviation Safety Agency (AESA) on 25 July 2012, as well as the following ratings:

- Fixed-wing multi-axis (MAF). Valid until 30/06/2017.

His class-2 medical certificate was also valid until 4 June 2017.

Based on the information provided, he had about 581 flight hours on fixed-wing ULMs, like the one in the accident, of which 280 hours had been on the same aircraft type as in the accident.

1.6. Aircraft information

1.6.1. General information

The accident aircraft, an ICP Savannah, is a single-engine, braced high-wing ultralight equipped with a fixed tricycle landing gear. It was manufactured in Italy in 2006 by ICP s.l.r with serial number 05-09-51-424.

Its general characteristics are as follows:

- Wingspan: 8.96 m
- Length: 6.25 m
- Height: 2.58 m
- Wing surface: 12.84 m^2
- Empty weight: 280 kg
- Maximum takeoff weight: 450 kg
- Fuel capacity: 72 liters
- Engine: Rotax 912 ULS, s/n: 5645625
- Propeller: three carbon fiber blades, 172-cm diameter, adjustable pitch on the ground.
- Never exceed speed (V_{NE}): 200 km/h
- Maneuvering speed (V_A): 136.8 km/h

- Maximum flap extended speed (V_{FE}): 96.5 km/h
- Stall speed:
  - With flaps extended (full flaps): 48 km/h
  - With flaps retracted: 56 km/h
- Load factor: +4g, -2g

It had a restricted certificate of airworthiness, Private - 3 category (normal), which had been issued on 13 September 2006.

Its was normally based at the Sant Feliú de Buixalleu aerodrome.

1.6.2. Weight of aircraft on accident flight

According to information provided by the pilot, before taking off from the Sant Feliú de Buixalleu aerodrome, he completely filled the fuel tanks, which had a capacity of 72 liters, with 95-octane gasoline.

At the time of the accident he estimated there were 50 liters left.

The density of 95-octane gasoline is between 0.709 and 0.727 kg/dm3 at 15° C. Assuming a density of 0.71 kg/dm^3 and a weight for each occupant of 70 kg, the aircraft's weight would have been as follows:

• Empty weight:	280 kg
• Pilot:	70 kg
• Passenger:	70 kg
• Fuel	51 kg
Total	**471 kg**

At the time of the accident, the weights would have been the same, except for that associated with the fuel that would be 35.5 kg, meaning that at that time the aircraft would have weighed 455.5 kg.

Since the aircraft's maximum takeoff weight is 450 kg, the above calculations show that the aircraft's weight at takeoff exceeded its maximum.

1.6.3. Engine information

The aircraft was equipped with a 912ULS Rotax engine with serial number 5645625. The engine's characteristics were as follows:

- Cylinders: four, opposed.
  - Diameter: 84.0 mm
  - Stroke: 61.0 mm
  - Displacement: 1352 cm^3
  - Compression ratio: 10,8:1
- Maximum power: 73.5 kW at 5800 rpm.
- Maximum continuous power: 69.0 kW at 5500 rpm.

The throttle lever has no physical stop on the control itself, and its travel is limited only by the limits present on the carburetors themselves.

1.6.4. Maintenance records

At the time of the accident, the engine and aircraft had the same 582:08 hours of operation.

The table below shows the information on the most recent significant maintenance checks of the aircraft's engine.

Date	Type of check	Hours
1/05/2014	100 h Change of oil filter, spark plugs, air filters, general check and lubrication	392
23/10/2015	100 h Change of oil filter, spark plugs, air filters, engine cleaning, general check and lubrication	490

The line maintenance manual for Rotax 912 engines issued by the manufacturer specifies periodic inspections every 25, 50, 100, 200 and 600 hours.

The 25-h and 50-h inspections are basically visual checks of the general condition of the engine, as well as level checks and cleanings.

The 100-h inspection includes an oil and filter change, an inspection of the magnetic plug and the replacement of the spark plugs.

As concerns the frequency of this inspection, the manual specifies to conduct it after 100 h of operation or yearly, whichever occurs first.

At the time of the accident, the aircraft had 581 h and 8 minutes, meaning it had 91 h and 8 minutes of runtime since its last inspection. Although the engine had not been run for 100 h since the previous inspection, said inspection had been carried out a little over 17 months earlier, meaning the one-year period had been well exceeded.

1.7. Meteorological information

1.7.1. General situation

Aloft there was a ridge in the west of the peninsula that was limited to the east by a deformation line. This caused a weak circulation from the north over the Iberian Peninsula and the Balearic Islands. There was an unstable low-pressure area over north Africa, but far away from the Balearic Islands. On the surface there was a large Atlantic high-pressure area (1032 hPa) centered northwest of the Azores that joined relative high-pressure areas to the north of the Peninsula and their Mediterranean sides with the Central European high-pressure area. Depression northeast of the Azores with the corresponding relative low-pressure areas over northwest Morocco and the Gulf of Cadiz, which strengthened the pressure gradient in the Strait of Gibraltar, favoring strong winds from the east. Stable weather and generally clear skies. Convection in the mountains of Cantabrian, Iberian and Pyrenean ranges (and some storms in the Pyrenees).

1.7.2. Situation in the accident area

AEMET does not have a station in Sant Feliú de Buixalleu. The closest stations are in Blanes (a little over 15 km to the SE), the Girona airport (about 20 km to the NE) and Sant Hilari (just under 20 km to the NW). The data from these stations were as follows:

- Blanes:
    - Wind from the south at about 11 km/h, with a maximum of about 17 km/h
    - Temperature around 18° C
    - 82% relative humidity
- Girona-Costa Brava:
    - Wind from the south at about 28 km/h, with a maximum of about 37 km/h
    - Temperature around 20° C
    - 48% relative humidity
    - Pressure of 1007.3 hPa
- Sant Hilari:
    - Wind from the south-southeast at 8 km/h, with a maximum of 17 km/h
    - Temperature around 17° C
    - 54% relative humidity

The weather service of Catalonia has a station in the town of Santa Coloma de Farners that is some 13 km northeast of the accident site. This station recorded the following wind readings:

Time period (UTC)	Average wind speed (km/h)	Direction (degrees)	Maximum speed (km/h)
15:00 - 15:30	16,6	150	30,2
15:30 - 16;00	16,2	147	33,5

The satellite images show that the skies were clear, with clouds over the Pyrenees. There were storms in the Pyrenees of Lleida with lightning and rain, but not in the accident area. The Girona-Costa Brava airport recorded some clouds with bases above 6000 feet.

1.8. Aids to navigation

Not applicable.

1.9. Communications

There is no record that the pilot communicated with anyone.

1.10. Aerodrome information

The restricted aerodrome of Sant Feliú de Buixalleu (Girona) has one 250-m grass runway in a 13/31 orientation.

The field is at an elevation of 82 m.

According to the procedures at the airfield, traffic in the pattern is to avoid flying over the town of Hostalric. Runway 13 is preferred in left-hand or right-hand patterns, with final from the valley.

These procedures also specify that a left-hand pattern to runway 31 can be used when strong winds are present from the N, NW or W. They also provide the following cautions:

WARNING:	patterns to runway 13 conditioned by terrain topography. Short or long pattern along the Riera Arbucies valley.
	Left-hand pattern to runway 31 not aligned with runway from west due to tall trees.
DEPARTURES:	from runway 13, even with gentle breeze from north. Takeoff from runway 31 dangerous due to leeward wind.
CAUTION:	final 13, turbulence with westerly or southwesterly wind.
	Landing on 31, careful with power line. Ensure landing.

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 and impact information

The aircraft crashed in a wooded area to the north of the aerodrome, practically along the extended runway centerline some 750 m away from the runway 13 threshold. The terrain in this area is at an elevation of 100 m, and the trees are some 15 m tall.

As the photograph in Figure 2 shows, the aircraft crashed in the forested area vertically, with the fuselage propped up by several trees.

The front parts of both wings were damaged by the impacts against the trees. These impacts broke the slat on the right wing at about its halfway point, causing the outboard fragment of the slat to detach.

The aircraft exhibited warping due to bending, especially at the trailing edges of the wings and the firewall, due to the vertical impact with the ground.

Two full blades and the root of the third were still on the propeller. Neither of the two blades showed impact marks or signs of damage under rotation.

The fragment that detached from the third blade was on the ground under the engine. It also had no marks indicating that it was rotating during the impact. There were marks, however, consistent with a bending force to the rear.

Figure 2. General view of aircraft (left). Close-up of engine and propeller (top right) and the detached slat fragment (bottom right)

All of the control surfaces were found correctly attached to the aircraft's structure, and there was continuity from the control levers/pedals to the surfaces.

Although some fuel had spilled, the tank in the aircraft was verified to contain gasoline.

The fuel lines did not show significant signs of deterioration. No signs of blockage were found. The mechanical fuel pump was full of gasoline, and it was verified to be working properly.

Two severed branches some 10 cm thick had been torn from two trees, one located 10.8 m away and the other 6.6 m away from the aircraft wreckage, in the opposite direction from the aerodrome.

1.13. Medical and pathological information

Both occupants suffered several broken bones, along with multiple cuts and bruises.

1.14. Fire

There was no fire.

1.15. Survival aspects

As the photographs in Figure 2 show, especially the one on the left, the aircraft's nearly vertical impact against the ground caused significant warping of the fuselage, characterized by considerable bending along the trailing edges of the wings.

The aircraft's cabin is located just beneath the wing, meaning the most significant warping occurred just behind the cabin. This made it possible for the cabin compartment to maintain its overall shape, though the compression caused all of the glass in the cabin (windshield and side windows) to break.

Although the most significant damage to the fuselage was aft of the wing, there was some damage due to bending that affected the bottom of the fuselage between the nose and the trailing edges of the wings.

The seats and safety belts did not break or fail in any way, and worked correctly to adequately restrain the aircraft's occupants.

1.16. Tests and research

1.16.1. Pilot's statement

In his statement, the pilot reported taking off from the Sant Feliú de Buixalleu aerodrome at around 13:30 and flying to the Moia aerodrome. He landed at the airfield and later went back to take off and return to the departure aerodrome.

At about 17:45, he was established on final for runway 13 to land at the airfield. He thought he was too high in the approach, so he reduced the throttle to idle to increase the descent rate. He immediately felt the ultralight fall very quickly, between 25 and 35 meters in a few seconds. He did not have time to take any actions since the aircraft impacted the tops of some trees and fell to the ground.

He thought that the engine stopped as the aircraft was descending, but he was not sure.

He recalled that prior to the flight he had checked the magnetos, which worked correctly. He did not notice anything unusual. He had also fully refueled the tank, which has a capacity of 72 liters.

He estimated that there would have been some 50 liters in the tank at the time of the accident.

When asked if his input to the throttle lever to reduce power was firm or soft, he replied that it had been rather firm.

1.16.2. Description of engine ignition system

This system consists of an ignition module and an external ignition assembly.

The ignition module includes various components: stator, rotor and the low-voltage coils.

The external assembly consists of two electronic modules, four dual high-voltage coils with ignition cables, eight spark plug caps and eight spark plugs.

The system is redundant so that a spark can be generated in all the cylinders even if one of the components fails.

Each cylinder has two spark plugs, each of which is controlled by one of the modules and supplied from different coils, such that a spark is always generated in all of the cylinders even if one of the electronic modules fails, or if any of the coils fails.

1.16.3. Engine inspection

The propeller was confirmed to rotate by hand normally. It did not produce any unusual noises.

All of the valves opened and closed normally. The compression values for all four cylinders were within specification.

The intake, fuel, exhaust, lubrication and cooling systems were inspected visually and found to be normal.

Both carburetors seemed to be working normally and were properly attached to the engine. The housings were opened and found to be full of fuel. The floats were verified to be in good condition and they actuated the fuel inlet valve, which worked properly.

The oil was a little dirty but in acceptable conditions.

There were metal particles attached to the magnetic plug, but within the acceptable limit. There were also metal particles in the oil filter.

The reduction gear for the propeller was disassembled, and all of its components (bearings, gears, etc.) found to be properly lubricated. The overload clutch did not show signs of having withstood any impact loads.

The ignition system was visually inspected. Nothing unusual was found. Resistance measurements were taken for the ignition unit as indicated by the manufacturer in the maintenance manual. All of the readings were within the specified range.

Since the ignition system could not be tested operationally, the two electronic modules and the four high-voltage coils were removed and installed on another engine to see if they generated a spark at the plugs, but without starting the engine.

These electronic modules (part number S/N 074818) are manufactured in Italy by Ducati. Their serial numbers are:

- Circuit A: 053107
- Circuit B: 074818

This test revealed that four of the spark plugs (one per cylinder) did not work. This was because one of the electronic modules (specifically, circuit B, S/N 074818) was inoperative.

This module was warmed up and the test repeated, after which the module worked properly.

The module was then allowed to cool to room temperature (25° C), after which it became inoperative once more. The engine was then started.

The engine started normally. After running for about one minute, the magnetos were tested. Both electronic modules worked correctly.

These tests were repeated after replacing the module from the accident engine with others with similar performance (inoperative at room temperature, but working after heating slightly). This yielded the following conclusions:

- All of the electronic modules checked remained inoperative after starting the

engine for a period ranging between 15 and 20 s.

- After this period, all of the modules began to work and continued to work properly while the engine was running.

- All of the modules remained operational for several minutes after the engine was stopped.

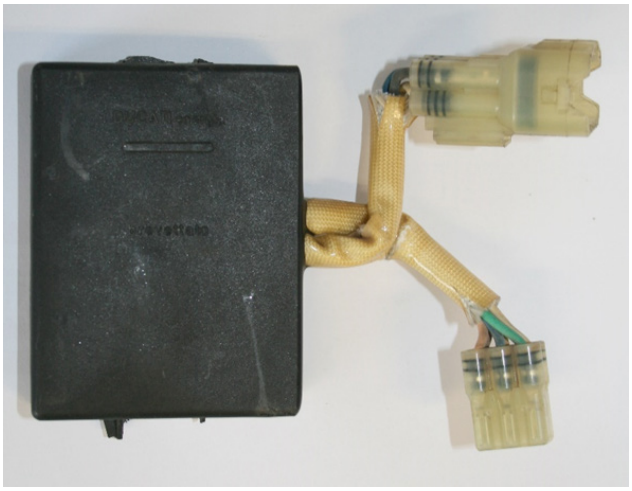

Figure 3. Photograph of electronic module in circuit B

The test was repeated by installing a completely inoperative module. The engine was verified to start normally with the other module. The magnetos were tested several times 15 seconds to 5 minutes after starting the engine, and the electronic module was verified to remain fully inoperative.

1.17 Organizational and management information

Not applicable.

1.18. Additional information

1.18.1. History of failures in electronic modules

BRP-Powertrain GmbH & Co KG ("BRP-Powertrain"), whose current name is BRP-Rotax GmbH & Co KG, which is the manufacturer of the Rotax engine used in the aircraft, issued an "INFORMATION RELEASE" on 20 January 2013 after becoming aware of several cases involving failures of electronic modules.

This document states that the cause of the failures found in many of the malfunctioning modules were the result of being subjected to temperatures in excess of the maximum allowed, which is 80° C.

Although not expressly stated in the release, the information provided by BRP-Rotax GmbH & Co KG indicates that the faulty modules that prompted the release to be issued were characterized by failing permanently. The faults in these modules were identified for the most part during the magneto test.

In an effort to determine the normal thermal operating conditions to which these modules are subjected, the engine manufacturer asked the manufacturers of aircraft that used Rotax engines to take actual readings of the temperatures reached by the modules in their aircraft. To take these measurements, the engine manufacturer specified the use of temperature-sensitive adhesive labels, which were to be attached to a specific area on the modules.

If the measurements indicated that the modules did not reach an operating temperature of 80° C, then no additional action was necessary.

According to the information provided by BRP-Powertrain, the manufacturer of the aircraft (ICP) reported that it had taken the temperature readings specified in the release, which were found to be below 80° C.

Although this information was targeted primarily at aircraft manufacturers, it was also provided to the owners of all aircraft with Rotax engines so that they could check the temperatures in their aircraft.

The Rotax distributor in Spain published this information on its website and on the magazine it publishes. It was also emailed to all those who were potentially affected. This information was also disseminated over the course of a six-month campaign, during which discounts were offered on the purchase of modules to owners who were affected.

As concerns the history involving failure modes in electronic modules like the one found on one of the modules in the engine installed on the accident aircraft, BRP-Powertrain reported it had no record of such failures.

The experience of BRP-Powertrain in the actual operation of these engines has shown that in the event of a failure of one of the electronic modules, the engine tends to exhibit problems starting at temperatures above 0° C, and that below 0° the engine may not start.

As for the Rotax distributor in Spain, it has no record of any case in which an electronic module behaving like the one found in the engine of the accident aircraft (not working at low temperature, but working after warming up slightly) stopped working once the engine was running.

1.19. Useful or effective investigation techniques

Not applicable.

2. ANALYSIS

2.1. Analysis of the aircraft wreckage and impact

As noted in point 1.12, an examination of the aircraft wreckage determined that all of the control surfaces were properly attached to the aircraft's structure and that there was continuity between the control levers/pedals and said surfaces.

As a result, the possibility that a fault in the aircraft's control systems may have played a role in the event is ruled out.

The fact that none of the three propeller blades had damage consistent with a rotating condition; the fracture mechanism of the detached blade, bent backwards; and the fact that the overload clutch did not show any signs of having experienced any significant load inputs, all clearly indicate that the engine was not supplying power when the aircraft impacted the ground.

This conclusion is consistent with the pilot's statement that, though he could not be sure, he thought that the engine had stopped immediately prior to the impact with the trees.

The aircraft struck a tree branch, and 4 m later it struck a second branch, after which it fell practically vertically inward toward the forest cover. This indicates that most of the aircraft's energy was dissipated in these two impacts. In light of the thinness of both branches, as well as of the short distance between the first impact and the location where the aircraft was found, it may be concluded that the aircraft's energy (directly proportional to its speed) before the first impact was quite low.

2.2. Analysis of the engine failure

As indicated in point 1.16.3, the evidence found during the inspection of the engine installed on the aircraft confirmed the signs observed in the propeller, which indicated that the engine was stopped when the aircraft impacted the ground.

This inspection did not reveal any problem or abnormality that might have caused the engine to stop during the flight, save for a fault that affected one of the electronic modules in the ignition system.

The functional tests conducted on said module showed that at a temperature of around 25° C, the module did not work, but that it began to work 15 to 20 s after the engine was started.

The pilot stated that before commencing the flight, he carried out the magneto test, the result of which was satisfactory. This indicates that at that time both modules were working correctly. The magneto test is done when the engine reaches a specific minimum temperature, which usually requires the engine to be running for several minutes after it is started. This finding is consistent with the failure found in the electronic module, which would have started to function while the engine was warming up.

The result of the operational tests conducted on the electronic module in the accident engine, as well as the experience with the performance of other modules with similar faults, indicate that once these components start working, they continue to do so with no signs of trouble while the engine is running. Consequently, it seems unlikely that the electronic module failed during the flight.

Another consideration is the fact that the design of the ignition system on the engine installed on the aircraft is redundant, such that if one of the modules fails, the other is able to keep the engine running, with the only consequence being a slight drop in engine speed.

Therefore, the engine stoppage that occurred during the approach to the Sant Feliú de Buixalleu aerodrome is not considered to have resulted from a fault in the ignition system.

Furthermore, based on the information provided by the pilot and confirmed by an inspection of the wreckage, there was fuel onboard when the engine stopped, which means that fuel exhaustion or an interruption in the fuel flow can also be ruled out as a cause of the engine failure.

In conclusion, no evidence was found of a problem or fault in the engine or in the fuel system that could explain the engine stoppage.

In contrast, it is well known that an overly fast motion of the throttle lever can cause the engine to stop due to the sudden change in the intake airflow conditions.

The pilot acknowledged that he made a sudden input to the throttle lever, which could have stopped the engine.

2.3. Analysis of the approach to the Sant Feliú de Buixalleu aerodrome

The runway at the Sant Feliú de Buixalleu aerodrome is in a valley through which the Arbucies River flows. The approach from the north, which was the one taken by the aircraft during the accident flight, is made by descending within this valley

and following the course of the river, which also descends in the direction of the approach.

The area where the aircraft crashed is some 750 m away from the runway threshold and is at an elevation of about 100 m. Assuming a standard approach slope of 5°, the aircraft should have flown over this point at an altitude of 148 m, or a little over 30 m above the tree tops. This figure closely agrees with the altitude at which the pilot said he was flying when he reduced power.

In Section 2.1, it was concluded that the aircraft's speed at the moment of impact with the first tree was quite low.

Downdrafts like the one the pilot reported feeling are characterized by being essentially convective (vertical) gusts of air, meaning they are not expected to have a significant effect on an aircraft's horizontal speed. As a result, the speed of the aircraft when the pilot reduced power is believed to have already been low.

If the engine also stopped at that point, then the propeller would have transitioned from providing thrust to creating drag, which would have undoubtedly contributed to slowing the aircraft.

As for the wind, which was generally blowing from the southeast, in the area of the accident it would be channeled by the valley, helped by the topography, such that it would strike the aircraft from the front at an average speed of about 16 km/h (4.4 m/s), gusting to 30-33 km/h (8.3-9.2 km/s).

At this point, it is worth mentioning the effect that ground friction has on wind speed, which causes the speed to decrease as the altitude drops, since the friction effect is higher as the distance to the ground diminishes.

In light of the above conditions, it seems feasible that the downward motion felt by the pilot did not result from a convective motion of the air, but rather from the decreased lift experienced by the aircraft as a consequence of its reduced speed, due both to the engine stoppage and to the lower wind speed resulting from the topography and from the ground friction effect.

Any aircraft in the traffic pattern has to maintain an altitude over the ground such that if it has an engine failure at any point in the pattern, it can glide to the runway. In this case, even though the aircraft was established on final to runway 13, not only was it unable to glide to the runway, it fell well short of the runway.

Even though the downward motion experienced by the aircraft limited its ability to

glide to the runway, this does not seem sufficient by itself to explain the long distance between the impact point and the runway.

It is possible that the pilot focused his attention on the runway in the valley and did not consider the proximity to the trees on the hillside below his position, thinking he was far enough above the ground when in fact he was quite close to the ground.

The most likely scenario, given the findings presented above, is that the approach was made at a low altitude and speed, during which the engine stopped. This was followed by a rapid descent due to the loss of thrust and the ground friction effect of the wind.

Although the calculations indicate that the aircraft's weight was above its maximum for the entirety of the flight, this factor is not considered to have contributed to the accident.

2.4. Considerations involving the failure mode identified in the electronic module

The experience acquired on the performance of electronic modules with failure modes like the one in the accident engine leads us to conclude that this kind of problem is only exhibited when the modules are at temperatures below 25° C, and moreover that the failure is temporary and lasts for a very short time (15 to 20 seconds).

Not a single case has been documented in which an electronic module with this failure mode, and that was working during the magneto test, failed afterwards during the course of a flight.

As a result, it may be concluded that this failure mode is not a risk to operational safety.

In the event that a module affected by this failure mode were to further degrade such that it remained inoperative for longer after the engine was started, or that it failed during a flight, this condition would be detectable in both cases, either during the magneto test in the first case, or by the effect it would have on engine speed in the second.

Even in this latter condition, the redundancy of the ignition system would ensure the continuity of the flight.

3. CONCLUSIONS

3.1. Findings

- The pilot had a valid and in force ULM pilot license.
- The pilot had a valid and in force class-2 medical certificate.
- The aircraft was airworthy and all of its documentation was valid and in force.
- The aircraft's weight was above its maximum limit for the entirety of the accident flight.
- The weather conditions were not limiting for the flight.
- The prevailing wind was from the south-southeast at an average speed of 15 km/h.
- The pilot reduced engine power during the approach to runway 13 at the Sant Feliú de Buixalleu aerodrome.
- The aircraft engine stopped immediately afterward.
- The aircraft descended suddenly, striking several trees before crashing to the ground.
- The aircraft impacted the terrain at a point some 750 m away from the runway 13 threshold at the Sant Feliú de Buixalleu aerodrome.
- The aircraft's two occupants suffered several broken bones and multiple cuts and bruises.
- The seats and seat belts worked properly, restraining the aircraft's occupants.
- The inspection of the aircraft wreckage did not indicate any evidence of a failure or malfunction in the aerodynamic control surfaces.
- The engine was not supplying power when the aircraft impacted the ground.
- No faults or anomalies were found in the engine that could explain why it stopped during the flight.

- One of the electronic modules in the engine ignition system was found to be working improperly.

3.2. Causes/Contributing factors

This accident is deemed to have been caused by an engine stoppage during the approach to the Sant Feliú de Buixalleu aerodrome (Girona), probably due to an excessive input made by the pilot to the engine lever when attempting to place it in idle.

The following factors contributed to this event:

- Flying the approach too slowly and too close to the ground.

- The pilot's incorrect assessment of the height, which caused him to reduce engine power prematurely.

- The effects caused by the topography and by the ground friction effect on the wind during the approach.

4. SAFETY RECOMMENDATIONS

No safety recommendations are issued.