



**COMISIÓN DE  
INVESTIGACIÓN  
DE ACCIDENTES  
E INCIDENTES DE  
AVIACIÓN CIVIL**

## **Report ULM A-008/2017**

Accident involving a Capella XSX TD aircraft,  
registration EC-ZCS, 2 km south of  
Carmona (Seville, Spain) on 3 May 2017



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DE ESPAÑA

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SUBSECRETARÍA

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DE ACCIDENTES E INCIDENTES  
DE AVIACIÓN CIVIL

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COMISIÓN DE INVESTIGACIÓN DE ACCIDENTES E INCIDENTES DE AVIACIÓN CIVIL

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

E-mail: [ciaiac@fomento.es](mailto:ciaiac@fomento.es)  
<http://www.ciaiac.es>

C/ Fruela, 6  
28011 Madrid (España)

## **Foreword**

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

In accordance with the provisions in Article 5.4.1 of Annex 13 of the International Civil Aviation Convention; and with articles 5.5 of Regulation (UE) n° 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**

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° ' "	Sexagesimal degrees, minutes and seconds
° C	Degrees centigrade
%	porcentaje
AEMET	Spain's National Weather Agency
AESA	Spain's National Aviation Safety Agency
cm	Centimeter
cst	centi-stoke
ft	Feet
g	grams
h	Hours
hp	Horsepower
hPa	Hectopascals
ICAO	International Civil Aviation Organization
Kg	Kilograms
Km	Kilometers
Km/h	Kilometers/hour
l	litres
LEAH	ICAO code for the Los Alcores aerodrome
LEEM	ICAO code for the El Manantío aerodrome
m	Meters
mg	milligrams
Min	Minutes
mm	Milimeter
N	North
N/A	Not affected
P/N	Part number
PPL(A)	Private pilot license (airplane)
ppm	Parts per million
PQI	Particle Quantifier Index
QNH	Altimeter subscale setting to obtain elevation when on the ground
rpm	Revolutions per minute
s	Seconds
SEP (land)	Single-engine piston rating (land)
ULM	Ultralight
UTC	Coordinated Universal Time
VFR	Visual Flight Rules
W	West

## **Synopsis**

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Owner: Private  
Operator: Private  
Aircraft: Capella XSX TD, registration EC-ZCS  
Date and time of accident: 3 May 2017 at 11:52 h<sup>1</sup>  
Site of accident: 2 km south of Carmona (Seville, Spain)  
Persons onboard: 2, no injuries reported  
Type of flight: General aviation - Private  
Phase of flight: En route  
Type of operation: VFR  
Date of approval: March 20<sup>th</sup> 2018

### **Summary of the event:**

On Wednesday, 3 May 2017, an amateur-built Capella XSX TD aircraft, registration EC-ZCS, with two persons onboard was preparing to go on a visual flight from the aerodrome of Los Alcores (LEAH), located in the town of Mairena del Alcor in Seville, to the aerodrome of El Manantío (LEEM), located in Badajoz. According to the pilot, before taking off, he filed the flight plan over the telephone, in which he stated that the aircraft's range was five hours and that the flight between the two aerodromes lasted two hours.

As they were flying over the proximity of the town of Carmona, the pilot noticed that the oil temperature gauge and the cylinder head temperature instrument indicated that the engine was overheating. Since they were far away from the airfield, he decided to make an off-field emergency landing. While making an emergency landing on a crop field, the aircraft flipped over, causing heavy damage to the aircraft.

The pilot and passenger sustained no injuries, though they were treated by medical services.

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1 All times in this report are local. To obtain UTC, subtract 2 hours.



The investigation has concluded that the likely cause of this accident was the execution of an off-field emergency landing in a crop field, required due to an engine that had overheated because of faulty maintenance.

## 1. FACTUAL INFORMATION

### 1.1. History of the flight

On Wednesday, 3 May 2017, an amateur-built Capella XSX TD aircraft, registration EC-ZCS, with two persons onboard was preparing to go on a visual flight from the aerodrome of Los Alcores (LEAH), located in the town of Mairena del Alcor in Seville, to the aerodrome of El Manantío (LEEM), located in Badajoz. According to the pilot, before taking on, he filed the flight plan over the telephone, in which he stated that the aircraft's range was five hours and that the flight between the two aerodromes lasted two hours.

As they were flying over the proximity of the town of Carmona, the pilot noticed that the oil temperature gauge and the cylinder head temperature instrument indicated that the engine was overheating. Since they were far away from the airfield, he decided to make an off-field emergency landing. While making an emergency landing on a crop field, the aircraft flipped over, causing heavy damage to the aircraft.

The pilot and passenger sustained no injuries, though they were treated by medical services.

### 1.2. Injuries to persons

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

### 1.3. Damage to aircraft

The aircraft sustained heavy damage.

#### **1.4. Other damage**

There was no additional damage with the exception of the marks left by the aircraft as it traveled over a plowed wheat field.

#### **1.5. Personnel information**

The pilot, a 65-year old Spanish national, had a private pilot license (PPL(A)) since 5 June 2007 with a SEP (land) rating that expired on 30 April 2019.

He had a class-2 medical certificate that was valid until 21 April 2018. There was an entry in his medical certificate stating, "Must wear corrective lenses for farsightedness and carry a spare set".

The owner, who was also piloting the aircraft, estimated that he had 216 total flight hours.

He had purchased the Capella XSX TD aircraft a few months prior, but since he did not have in force a license to pilot ultralights, he was unable to use it until May. In order to be able to pilot it, the previous owner had asked AESA to modify the Certificate of Airworthiness to no longer classify it as an ultralight aircraft. On 15 March 2017, AESA issued said Certificate of Airworthiness. Prior to the accident, he had flown it three times on local flights from the aerodrome of Los Alcores. On 1 May he flew 1 h 35 minutes and on 2 May he made two flights, one lasting 2 h and the other 1 h 30 minutes, meaning he had a total of 5 h 5 min of flight time on that aircraft on the day of the accident.

#### **1.6. Aircraft information**

The Capella XSX TD aircraft, with registration EC-ZCS and serial number 98088-1249, was built in the year 2000 and registered in Spain's Aircraft Registry on 17 April 2001. On 25 May 2017, Spain's Aircraft Registry issued a new registration certificate under the name of the current owner.

The aircraft was equipped with an 85-hp, 3300-rpm Jabiru 2200 engine with manufacturing number 22A2503, as noted in the engine logbook. According to this information, the engine had been overhauled and had 867 h of operation when it was installed on the aircraft on 9 August 2012.



**Figure 1.** Photograph of the accident aircraft

On the day of the accident, the aircraft had a Special Restricted Certificate of Airworthiness in the “Private (3)<sup>2</sup> Special<sup>3</sup>” category, issued on 15 March 2017 by the National Aviation Safety Agency. Previously, on 27 September 2016, the prior owner<sup>4</sup> of the aircraft had requested changing the aircraft’s category from “Private-3-Normal<sup>5</sup> ULM” to “Private (3) Special”. This change did not entail any physical modifications to the aircraft. The maximum certified weight remained at 396 kg, with a basic empty weight of 252 kg; therefore, according to the definition of ULM contained in the Royal Decree 1591/1999, the accident aircraft continued to be an ultralight aircraft.

According to the aircraft features sheet adhered to the Airworthiness Certificate, the aircraft had a single fuel tank, placed in the fuselage, which can hold 55 liters, with 7.57 liters of fuel being non-usable.

However, on the day of the accident, it had two additional fuel tanks with 45 l, one in each wing. The installation of these tanks was not recorded in the “Flight records and information of the aircraft logbook”, which did include other previous maintenance tasks.

The most significant maintenance activities previous to the accident recorded in the “Flight records and Information of the aircraft logbook” are listed below in chronological order:

- 
- 2 The (3) indicates that an aircraft is only suited for visual flight.
  - 3 The “Special” technical category indicates that it is only authorized to fly with the limitations specified in the documents attached to the Type Certificate.
  - 4 The mechanic of Aerosevilla Mantenimiento de Aeronaves, representing the previous owner of the aircraft, has sold the accident aircraft to its present owner, which was at the same its pilot.
  - 5 The “Normal” technical category indicates that it is only authorized to make normal flights, excluding any acrobatic maneuvers.

- On 29 April 2015, at the Aerodrome of Los Alcores, Aerosevilla Mantenimiento de Aeronaves conducted the last 200-h or 2-year inspection of the aircraft and engine for the purpose of renewing the Certificate of Airworthiness. At that point, the engine had 155 h 20 min, as per the engine logbook, and the aircraft had 429 h 35 min.
- Subsequently, Aerosevilla Mantenimiento de Aeronaves replaced the tail skid to a tricycle type because the aircraft was being transferred to a new owner who did not know how to fly tailwheel aircraft. This change required a new inspection of the aircraft, conducted on 2 June 2015, to renew the Certificate of Airworthiness.
- On 6 February 2017, the aircraft and engine were checked. At the time, the engine had 228 h 10 min, as per the engine logbook, and the aircraft had 515 h 15 min<sup>6</sup>. This checking was performed in order to modify the aircraft's Certificate of Airworthiness and stop classifying it as an ultralight aircraft.
- Subsequently, on 29 February 2017 (sic), the support gasket for the carburetor was replaced and the engine was inspected due to a change in documentation.
- Finally, on 30 April 2017, an oil leak from the engine's distributor cap was repaired.

On the day of the accident, the aircraft had 519 h 20 min and the engine 232 h 15 min.

The airplane had been unused for a long time, first in Alicante, from 22 August 2015<sup>7</sup> until 20 May 2016<sup>8</sup>, and then at the aerodrome of Los Alcores, from 30 May 2016 until 1 May 2017<sup>9</sup>. The mechanic who used to maintain the aircraft stated that, at least during the time when the aircraft was parked at the aerodrome of Los Alcores, it was not stored according to Jabiru procedures, meaning that no measures were taken to avoid potential corrosion or degradation over this long period of time.

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6 On this date, the difference between engine hours and aircraft hours was different from that on 29 April 2015 because for every flight between the two dates, 5 additional minutes were logged for the engine hours. The engine hours also failed to take into account the two flights that were made on 22 August 2015.

7 On August 22<sup>nd</sup> 2015 the aircraft flew from Beas del Segura aerodrome to Catral aerodrome in Alicante. The pilot was the mechanic of Aerosevilla Mantenimiento de Aeronaves.

8 On May 20<sup>th</sup> 2016, the aircraft flew from Catral aerodrome to Los Alcores aerodrome. The pilot was again the mechanic of Aerosevilla Mantenimiento de Aeronaves.

9 On May 1<sup>st</sup>, 2017 the aircraft performed a local flight with take-off and landing from Los Alcores aerodrome. The pilot this time was the present owner of the aircraft.

During the investigation, the owner/pilot stated that he did not even have the datasheet attached to the aircraft's Restricted Certificate of Airworthiness or the maintenance schedule. These documents are required to use the aircraft, according to the Order of 31 May 1982, which approved the new Regulation for Amateur-Built Aircraft. He also did not have the User's Manual, which the builder has to deliver, according to the Order of 14 November 1988, which lays out the airworthiness requirements for powered ultralight aircraft (ULM).

### **1.7. Meteorological information**

AEMET does not have weather data for the aerodrome of Los Alcores; however, given the prevailing weather conditions, the data from the closest stations in Carmona-Villegas and the Seville Airport, provided below, should be valid.

- Wind from the east, between 050-110° at both stations, at 20 km/h at the Seville Airport and 18 km/h at the station in Carmona, gusting to a maximum of around 28 km/h from the northeast.
- Good visibility on the surface.
- Cloud cover: clear.
- Temperature of 24° C at the Seville Airport and around 23° C at the station in Carmona.
- QNH around 1013 hPa.
- Relative humidity around 50%.
- No significant weather phenomena.

### **1.8. Aids to navigation**

No aids to navigation are available on this type of flight.

### **1.9. Communications**

None.

### **1.10. Aerodrome information**

The aircraft was flying from the aerodrome of Los Alcores, located in the town of Mairena del Alcor in Seville, to the aerodrome of El Manantío, located in Badajoz.

The aerodrome of Los Alcores is at geographic coordinates 37° 19' 46" N, 5° 43' 25" W at an elevation of 150 ft. It has one 650-m long, 20-m wide asphalt runway in a 05/23 orientation.

### **1.11. Flight recorders**

Not applicable.

### **1.12. Wreckage and impact information**

The aircraft wreckage was located at geographic coordinates 37° 26' 6.1" N, 005° 37' 4.9" W, near the town of Carmona, Seville. The aircraft, which had overturned, was inside a wheat field measuring several hectares.

There were barely any marks on the field. No wheat stalks were found to have been cut by the propeller. The marks on the field revealed that the initial contact had been by the main gear followed by the nose gear and the main gear again. The nose gear eventually collapsed.

The engine was on the ground, detached from its mount. The wings had no significant damage. The cockpit had retained its integrity. The seatbelts worked properly and the pilot stated they were fastened, which had undoubtedly prevented major injuries. One of the pedals was broken. The pilot stated that he had probably broken it when he exited the aircraft. He also said that they certainly would have moved levers and other aircraft components when exiting the aircraft.

There was a smell of leaked fuel.

The photographs below show the condition of the aircraft after the accident:



**Figure 2.** Aircraft on wheat field after accident

### **1.13. Medical and pathological information**

There is no indication that physiological factors or impairments affected the pilot's actions.

### **1.14. Fire**

There was no fire.

### **1.15. Survival aspects**

One farmer, who witnessed the accident from a nearby field while he was plowing with a tractor, alerted the Civil Guard. The firefighters, who had been notified by the Civil Guard, deactivated the ballistic parachute on the aircraft, which the pilot recovered.

The pilot and passenger exited the aircraft under their own power. The pilot was not injured. The passenger, though was not hurt in the accident, had a slight ankle luxation when leaving hastily the accident zone, and was treated by medical personnel in Carmona.



## 1.16. Tests and research

### 1.16.1. *Statement from the pilot*

He had purchased the amateur-built aircraft from its previous owner, who had not built it, some time ago. As a result, he had not flown it much, though he did have experience on aircraft like the Cessna and Piper.

Before the accident, the aircraft had not given him or the previous owner any problems.

He also stated that following several maintenance inspections, the aircraft had recently been reclassified from ULM to "General Aviation" at his request, since he did not have a license to pilot ultralight aircraft.

He refueled the aircraft at Los Alcores aerodrome, putting 25 liters in each of the aircraft's two fuel tanks, which is equivalent to 18 kg in each wing. The occupants were not carrying any type of luggage. Since the pilot's weight is 63 kg and the passenger's is 104 kg, the total weight at the time of takeoff, given the aircraft's empty weight of 252 kg, would have been 454 kg<sup>10</sup>.

Before initiating the flight with destination Badajoz, the maintenance technician, together with the companion of the accident pilot, performed a short local flight, taking off and landing at Los Alcores aerodrome, in order to heat/verify the engine.

Later, after doing the pre-flight inspection and warming up the engine for about five minutes, the accident pilot and his companion took off en route to Badajoz (aerodrome of El Manantío), as per his telephoned flight plan. They were in constant contact with the Seville control center.

At the time of the accident, they had not yet reached their cruise phase and were climbing at an altitude of 300 or 350 ft. The climb was limited by the temperature at the time. After flying over Carmona, he saw that the engine was overheating, with the temperature gauges for both the oil and the cylinder heads in the red zone. He retracted the flaps and turned twice to the right to head into the wind and make an emergency landing in a wheat field. He thought about returning to Los Alcores but ruled it out, as he did not think he had enough time. He also thought about landing on the road, but there were vehicles on it. He finally landed on the wheat

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10 The pilot knew that the maximum certified weight was 396 kg, thus the weight of both people on board together with the fuel weight should not be above 144 kg. However, the pilot considered the maximum certified weight as unreal, thinking that the Airworthiness Certificate had been given to an impossible achievement.

field in the direction of the rows. The wheat was fairly high, between 80 and 100 cm. The nose wheel collapsed when it contacted the soft ground and the aircraft flipped over. He shut the fuel valves and they exited the aircraft under their own power, uninjured.

During the investigation, the pilot was asked to confirm if he himself had installed the two additional fuel tanks in the aircraft. He did confirm this and stated that the capacity of both tanks was equal to that of the central fuel tank. He insisted that the total fuel capacity of the aircraft had not been modified as he had cancelled the central fuel tank installed in the fuselage. This modification, according to the pilot, was made before the renewal by AESA of the Airworthiness Certificate was obtained.

#### **1.16.2. Engine inspection**

The condition of the engine was checked to attempt to identify what could have caused the engine to overheat.

The external inspection revealed that the exhaust pipes were covered in an insulating fabric that hampered heat dissipation. The engine manufacturer, Jabiru, which was consulted following the engine inspection, did not approve taping the exhaust pipe.

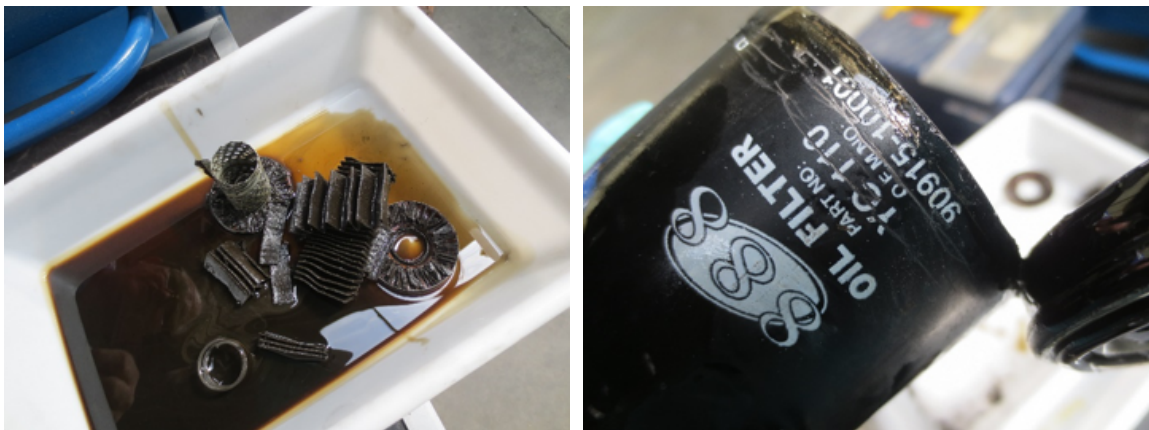


**Figure 3.** Close-up of taped exhaust pipe

Following the external inspection, the cooling air lines leading to the cylinders were disassembled. Nothing out of the ordinary was found.

The oil was then drained from the engine and a sample drawn for analysis<sup>11</sup>. The oil was dark and had metal particles.

The oil filter was removed and cut to inspect the paper filter element. The pleats in the paper gave way on contact. The paper had no consistency, it was brittle and fragile. This may have been due to being very old, being in use for an excessive length of time or to being stored in bad conditions. Moreover, the filter recommended by the manufacturer (P/N PG10162N in the Jabiru Engine Parts Book) was not the one installed in the engine.



**Figure 4.** Close-up of oil and oil filter

The probes for measuring the cylinder head temperatures were removed. The probe for the front left cylinder was broken where it attached to the cable. The color of the fracture indicated that it had broken off a long time ago, meaning it would have provided either no temperature reading or a false reading for that cylinder head. The rest worked correctly.

The oil supply lines to the rocker arms and the valve stems were then disassembled. The left line was plugged by silicone at the end where the oil is supplied at pressure from the crankcase, and the O-ring was deformed. As a result, the oil was not flowing to the rocker arms, valve springs or stems, and the operation of these parts with no lubrication caused the engine to overheat. The oil intake orifice on the line for the right side was not plugged, even though silicone had been applied to it as well, possibly in an attempt to prevent oil leaks, given the bad condition of the O-rings.

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<sup>11</sup> The results of this analysis are presented in the next section.

The transmission of movement in the propeller-crankshaft-piston rods-plungers was checked. If the propeller was turned, the plungers were seen moving through the spark plug holes. There was no seizing.

The front left cylinder (as seen looking from the accessory case to the propeller) was disassembled to check its condition:

1. The pushrod for the intake valve was corroded and had silicone applied to it. Valve pushrods do not normally corrode while in use because they are covered in oil. The engine manufacturer, Jabiru, thus suspected that they had been removed from the engine and exposed to the air.
2. There was also corrosion inside the cylinder. This may have been due to periods of inactivity with inadequate or no preservation.

The plungers and rings on the piston were inspected. It was noticed that the rings did not have their respective openings shifted 120° between one ring and the adjacent ring. The color of the plunger under the rings indicated flashing due to the undesired escape of gases from the combustion chamber. This happens when the rings do not provide adequate sealing, which would cause the temperature in the cylinder/engine to rise.



**Figure 5.** Close-up of cylinder and piston exhibiting corrosion



**Figure 6.** Close-up of piston with signs of overheating

The seats of the intake and exhaust valves were also checked. When gasoline was added to the engine, it leaked out the two valves. This means there was a loss of compression due to improper seating of the valves.

Based on the condition of this cylinder, the investigators did not deem it necessary to disassemble the remaining engine cylinders.

The carburetor was disassembled and the internal components checked: float valves, membranes and needle. Nothing out of the ordinary was observed.

Finally, the operation of the cylinder temperature gauge was checked (VDO 1 231 003 064 A). The reading was correct throughout the 50 °C to 300 °C range. The oil temperature gauge was also checked (VDO 310 010 015) and verified to be correct at 50 °C and 150 °C, corresponding to the resistance values indicated by the manufacturer.

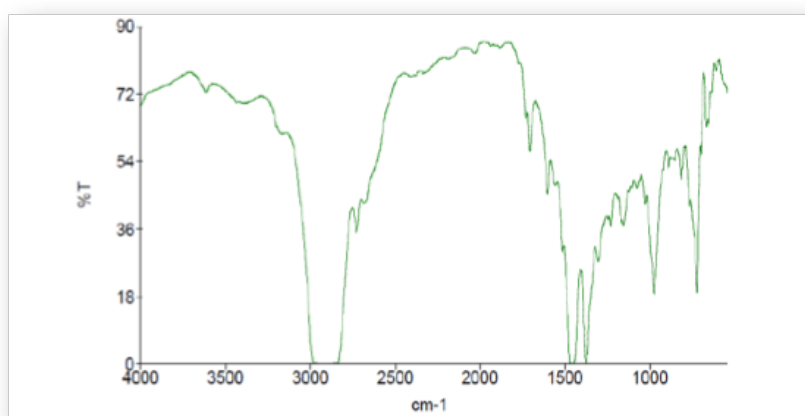
### **1.16.3. Analysis of engine oil**

The mechanic stated that the oil used in the accident aircraft was AeroShell W100, as recommended by the engine manufacturer, Jabiru. A sample of oil was taken from the engine and chemically analyzed in the laboratory, the results of which are shown in the table below:

Test	Standard	Results
Kinematic viscosity test	ASTM D-445	94,32 cst
Total Acid Number (TAN)	ASTM D 664 o 974	3,01 mg KOH/g
Wear metals	ASTM D 5185	Fe Cu Mo Pb Sn Cr Al Ni B Na (ppm) 67 25 0 373 4 6 21 3 69 1
Additive elements	ASTM D 5185	P Zn Ca Mg Li (ppm) 1749 1809 2791 13 0
Metal contaminants	ASTM D 5185	Si (ppm) 66
Oxidation	/	3 A/0,1 mm
Water content	UNE EN ISO 12937	<0,1%

Test	Standard	Results
PQI		28
Particle count	NAS 1638	12

The graph below shows the infrared spectrum for the oil sample taken from the engine:



**Figure 7.** Infrared spectrum for the oil sample taken from the engine

After obtaining the results of the chemical analysis on the engine oil, Jabiru was contacted for its assessment. The manufacturer noted that:

- The values of the additives Zn and Ca were very high. AeroShell W100 and Aero Oil 15W-50 oils have no additives; therefore, this oil sample did not correspond to those oil types. Jabiru added that it does not approve of the use of oils with additives in its engines. According to Jabiru, the oil in the accident aircraft was an automotive oil. The use of oil with detergents (as is the case with automotive-grade oil) can lead to pre-ignition in aviation engines that require oil with the MIL-L-22851 specification. This could result in high cylinder head temperatures and in high oil temperatures.
- The lead (Pb) content was probably due to the fuel used. If Avgas is used, the Pb content is approximately 5,000 ppm when the oil is changed after 25 h. Since the piston did not have Pb deposits, Jabiru thought that Mogas had been used recently.
- The iron (Fe) content could have come from the corrosion of the steel cylinders.



- The silicon (Si) content could have been due to dust contamination of the oil from not replacing the oil filter in a long time or from not using an air filter.

#### **1.16.4. *Statement from the mechanic***

The mechanic who had performed the most recent maintenance activities on the aircraft was contacted during the investigation.

He stated that the aircraft had in origin a fuel tank of 55 liters. After obtaining the renewal of the Airworthiness Certificate by AESA, the present owner of the aircraft added two additional tanks, one in each wing, with a capacity of 45 liters. After this amendment, the total fuel capacity of the aircraft was 145 kg. The empty weight raised from 252 kg to 344 kg as per the statement of the mechanic, as a result of these new two tanks installed.

The day of the accident the aircraft had both fuel tanks in the wings at full capacity, thus it had 90 liters. Taking into account the empty weight of the aircraft, the weight of the pilot (between 70 and 80 kg), the weight of the passenger (around 130 kg) and the above fuel quantity the aircraft took off with approximately 634 kg as per calculations of the mechanic. Therefore it took off far above the maximum certified take-off weight which is 396 kg.

The mechanic stated that the engine had overheated due to excess weight. He added that prior to takeoff, he told the pilot he was too heavy and recommended that he not fly with another occupant.

After the engine inspection, the mechanic was again contacted to clarify the following questions:

- When and why the exhaust tube was taped. He stated that the previous owner of the aircraft had already purchased the aircraft with the exhaust tube taped and that it was normal practice to keep the lines near the exhaust pipe and the fibers on the cowling from overheating.
- How and when the engine oil was changed. He stated that the oil was changed on 30 April 2017. He had purchased the oil on 10 March 2017. He used the oil recommended by the manufacturer, Jabiru, AeroShell 100. It was not mixed with used oil; in other words, all the oil in the engine was changed.
- As concerns the oil filter, he stated that he had replaced it in February 2017, and that the replacement filter had been stored in his workshop for one year.

He also said he had installed a filter different from that authorized by Jabiru because it was compatible with the original and had never given him problems.

- He was asked if he had applied silicone to the lines that supply oil to the rocker arms and valve stems, to which he replied no.
- In the last overhaul, he did the compression tests, which gave a result of 75/80. He did not see any leaks in the intake or exhaust valves during the test.

### **1.17. Organizational and management information**

As previously described, on 6th February 2017 a general checking of the aircraft and the engine was carried out at Aerosevilla Mantenimiento de Aeronaves.

This maintenance workshop is not a center neither admitted nor accredited by AESA.

In fact, the present regulations do not establish the requirements the maintenance centers and maintenance personnel must comply to perform the maintenance and airworthiness revision of the amateur-built aircraft, nor the necessity of performing such maintenance and airworthiness revision in centers admitted and accredited by AESA.

### **1.18. Additional information**

#### ***1.18.1. Previous incident***

On Sunday, 9 June 2013, the same aircraft experienced a runway excursion while taking off from the airfield of Alcocer de Planes (Alicante). This incident was not considered serious by the CIAIAC, and thus no formal investigation was conducted.

As a result of this incident, the right main landing gear leg broke, and the hubs and wheels had to be replaced as well.

#### ***1.18.2. Regulatory status. License to pilot an amateur-built aircraft***

Article 4 of the Order of 31 May 1982, which approves the new regulation for the construction of amateur-built aircraft, states: "Operating these aircraft shall require a private pilot license, as well as the qualifications specified by the Under Secretary for Civil Aviation for each case, as determined by the characteristics of the aircraft, by requiring the relevant familiarization and experience". In light of this, the National



Aviation Safety Agency was asked which license is needed to pilot an amateur-built aircraft.

The National Aviation Safety Agency stated that the Order of 31 May 1982 was written before the licenses for ultralight pilots were defined. Specifically, Royal Decree 2876/1982 of 15 October, which regulates the registration and use of ultralight aircraft and amends the registry of non-commercial private aircraft, specifies that an ultralight pilot license is required to use these aircraft.

In this case, the principle that the later regulation supersedes the earlier one applies. Furthermore, a royal decree also carries more legal weight than a ministerial order. Therefore, the requirements specified in Royal Decree 2876/1982, which state that an ultralight pilot license is required for crewmembers of ultralight aircraft, applies.

In conclusion, if an amateur-built aircraft is classified as an ultralight, the required license is that for an ultralight pilot.

***1.18.3. Regulatory situation. Minimum documentation that the manufacturer must deliver to the user***

Article 10 of Order dated 14 November 1988, which establishes the airworthiness requirements for the Ultralight Motorized Aircraft (ULM), specifies the minimum documentation the manufacturer must deliver to the user, as follows:

- a) An user manual describing:
  - Normal procedures
  - Operation limits
  - Emergency procedures
  - Performance
  - Weight and balance limitations, including instructions for their adjustment.
  - Type of fuel and lubricant allowed.
  - Processes for assembling, disassembling and storage.
  - Instructions for the periodic maintenance, which must indicate the most important operations to be made to guarantee the airworthiness of the aircraft, paying special attention to the anchorage of the supporting elements, engine and landing gear.
- b) A maintenance logbook, in which the user must write down all the important operations affecting the maintenance, such as assemblings, disassemblings, replacement of blades and engines, or their repairs. In the note it must be indicated the date and the running times to which the incidence is referred.

Furthermore, article 19 of Order dated 31 May 1985, which approves a new Regulation for the Manufacturing of Amateur-Built aircraft, establishes the documentation according to regulations for the use of the aircraft and mention, among others, the necessity of a maintenance program.

#### **1.18.4. *Regulatory situation. Maintaining airworthiness***

Article 15.2 of the Order of 31 May 1982, which approved the new Regulation for the Construction of Amateur-Built Aircraft, states that a Certificate of Airworthiness shall be valid for two years or two hundred flight hours, and that its renewal requires an overhaul of the aircraft, except for that aviation material or equipment that has its inspection requirements.

However, said Order does not specify who is responsible for performing this overhaul of the aircraft, nor who is responsible for maintaining and preserving the airworthiness of the aircraft.

Subsequently, the Order of 14 November 1988 was published, which laid out the airworthiness requirements for Powered Ultralight Aircraft (ULM). Article 12 of this Order specifies that the owner is fully responsible for maintaining and preserving the airworthiness of the aircraft. The Authority reserves the right to inspect the condition of an aircraft to verify its airworthiness, and the owner or operator of the ULM must demonstrate that the aircraft maintains the airworthiness conditions with which it was built.

This subsequent Order places the responsibility on a ULM aircraft's owner or operator to keep it airworthy. The Authority shall, when deemed appropriate, inspect the airworthiness of the aircraft. This Order, however, does not regulate how to perform the overhaul of an amateur-built ULM that is required to renew the certificate of airworthiness.

AESA has indicated, during the comments period, that for the present case the aircraft owner is the responsible for the maintenance and preserving its airworthiness, and also for the overhaul.

#### **1.18.5. *AESA procedure for renewing the Certificate of Airworthiness of amateur-built aircraft***

The AESA procedure states that a Certificate of Airworthiness may have to be renewed for various reasons, including:

- The certificate has expired or is close to expiring.
- The certificate is or will soon become invalid due to the introduction of changes to the aircraft that affect or could affect the results of the flight tests required, or if a change in the ULM classification is requested.

In the first case, during the renewal process the aircraft is verified to be in compliance with the design authorized by AESA, to comply with the applicable airworthiness directives and that it is in condition to be operated safely. The relevant documents are reviewed to ensure that the requirements for maintaining both the initial and continuing airworthiness are being satisfied.

When a restricted certificate of airworthiness has to be renewed for the second reason, the flight tests must be satisfactorily repeated, as the results of said tests might be affected by the modifications made or by the change in ULM classification.

As a general rule, the procedure requires that a physical inspection of the aircraft be done for every renewal (with a flight test if possible).

In both cases, the renewal results in the certificate being renewed for a period equal to the original certificate duration.

AESA was formally requested to detail how the certificate of airworthiness had been renewed for this particular case. AESA supplied the inspection report/technical opinion, which states that an AESA inspector traveled to the aerodrome of Los Alcores. No documents were provided detailing the specific activities carried out by the AESA inspection to renew the certificate of airworthiness. Specifically, it is not known if the AESA inspector conducted a physical inspection of the aircraft.

AESA indicated that for this particular case no flight test was performed. Since the aircraft's weight, maintenance schedule and station license remained unchanged, the AESA inspector thought that no flight tests were necessary to authorize the change of category and the subsequent renewal of the certificate of airworthiness.

#### ***1.18.6. Jabiru engine maintenance manual***

Section 7.2.3 of the Maintenance Manual describes the steps to take in order to preserve the engine when the aircraft is in non-operational status for more than 60 days. These steps include:

- Using an oil can or spray atomizer, spray preservative oil through a spark plug hole of each cylinder with the piston in the down position, to inhibit corrosive.
- Use Shell Aero fluid 2UN or a similar engine corrosion inhibitor.
- Remove the rocker covers from each cylinder head and spray corrosion inhibitor oil into all the rocker chambers.

Section 7.2.4 instructs to conduct monthly inspections of at least one cylinder during the aircraft's period of inactivity to check for corrosion. The inside of the cylinder can be inspected through the spark plug hole.

Section 8 of the Maintenance Manual specifies the maintenance tasks that must be performed every 25, 50, 100 and 200 hours and during the annual inspection. For example:

1. The cylinders must be checked every 50, 100, 200 hours and during the annual inspection. Section 9.16 specifies how to check the chamber.
2. Compression or leak test every 50, 100, 200 hours and during the annual inspection. Section 9.18 of the Maintenance Manual describes how to do these tests.
3. Oil and oil filter change every 25, 50, 100, 200 hours and during the annual inspection. Section 9.5 of the Maintenance Manual describes how to change the oil and oil filter.

#### **1.19. Useful or effective investigation techniques**

Not applicable.

## 2. ANALYSIS

A timeline for the most significant events is provided below:

1 – The aircraft had been parked for a long time, first in Alicante, from 22 August 2015 until 20 May 2016, and then at the aerodrome of Los Alcores, from 30 May 2016 until 1 May 2017. During this time, at least while it was in Los Alcores, no measures were taken to preserve the engine, as deduced from the internal corrosion observed in the engine when it was inspected.

2 – On 6 February 2017, the engine was checked for the last time in order to renew the Certificate of Airworthiness and stop classifying the aircraft as a ULM and modify it to “General Aviation. Private”. During this last checking, the following abnormalities should have been identified: the corroded condition of the engine, and the leaks in the intake and exhaust valves. Moreover, the maintenance technician who did the checking thought it was appropriate for the exhaust pipe to be taped, when this practice is expressly not approved by the engine manufacturer. What is more, an oil filter was used that was not recommended by the manufacturer, Jabiru. Therefore, the checking of the engine and the maintenance tasks that were carried out are deemed to have been deficient.

3 – On 15 March 2017, AESA renewed this aircraft’s certificate of airworthiness. In its procedure, AESA specifies that the documents pertaining to the aircraft’s condition be reviewed and that, as a general rule, the aircraft should undergo a physical inspection (with a flight test if possible). In order to certify that the aircraft was airworthy, AESA based its decision mainly in the report made by Aerosevilla Mantenimiento de Aeronaves, which described the last maintenance tasks performed during the last overhaul<sup>12</sup>. They are not known, as they have not been presented as documentary evidence, which concrete tasks were carried out during the physical inspection. It is known, however, that AESA did not deem it necessary to carry out a flight test to renew the aircraft’s flight certificate.

4 – Subsequently, on 30 April 2017, an oil leak was noticed on the engine’s distribution cap and the oil was changed. The oil that was used was automotive oil, and not the one recommended by the manufacturer, Jabiru, as the analysis of the engine oil sample concluded.

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12 Applicable regulations require an overhaul on the aircraft to renew its Airworthiness Certificate.

5 – Prior to the accident, on 1 and 2 May, the pilot performed a few local flights in order to familiarize himself with the aircraft. He did not notice any problems with the aircraft during these local flights.

6 – The accident occurred on 3 May.

During the investigation, it has not been possible to determine the exact weight with which the aircraft took off, as its empty weight is not known (after the two additional fuel tanks in the wings had been installed) nor the fuel quantity with which the aircraft took off. What seems certain is that the total weight exceeded its certified maximum weight.

It is unquestionable that the maintenance status of the aircraft contributed decisively in the engine overheating, and specifically due to:

- The use of a presumably automotive oil with additives instead of the oil recommended by the manufacturer
- The bad condition of the oil filter
- The application of silicone, which plugged the left oil supply line to the rocker arms and valve stems
- The lack of leak-tightness in the plunger rings in at least one of the cylinders
- The loss of compression resulting from the improper seating of the intake and exhaust valves on at least one of the cylinders<sup>13</sup>
- The taping of the exhaust pipes, which hampered heat dissipation
- The state of corrosion of the pistons and cylinders.

7 – Once the oil and cylinder head temperature indicators alerted the pilot to the engine overheating, he decided to land as soon as possible. According to his statement, he weighed the possibility of returning to the aerodrome of departure, but ruled that option out since he thought the engine might seize. During the investigation, the engine manufacturer stated that an emergency landing is not required if the engine overheats. However, the engine Maintenance Manual does not specify how long the airplane can continue flying with an overheating engine before it seizes. By opting to land on a wheat field, the impact of the landing gear was

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13 Only the condition of one engine cylinder was checked during the engine inspection.

dampened by the soft terrain, although the aircraft ended up turning over. Because the cockpit retained its integrity and the aircraft's occupants had their seat belts fastened, they were not injured during the accident.

8- During the investigation it has not been possible to determine the date in which the two additional fuel tanks in the wings were incorporated. Such modification was not recorded in the "Flight records and Information of the aircraft logbook", in which other maintenance tasks made in the aircraft did have been written down.

What is certain is that the aircraft at the time of the accident was not airworthy, as it was not according to the features sheet adhered to the Airworthiness Certificate.

This Commission deems it appropriate to issue safety recommendations on the following aspects:

1 – AESA has established a procedure for renewing the Certificate of Airworthiness of amateur-built aircraft in which, as a general rule, the aircraft is to be physically inspected prior to each renewal (to include a flight test if possible). The CIAIAC believes that a physical inspection is always necessary to determine if the aircraft is airworthy or not; as a result, it recommends that AESA, prior to renew a certificate of airworthiness, always carry out a physical inspection of the aircraft, and write down all the concrete tasks performed during it, and the aircraft elements inspected.

2 – In order to renew the certificate of airworthiness, the Order of 31 May 1982 requires an overhaul of the aircraft, except for that aviation material or equipment that has inspection requirements. Neither the national nor the European regulations specify what maintenance centers or personnel are authorized to overhaul amateur-built aircraft. However, the DGAC and AESA are working on a draft regulation that will specify the requirements that maintenance centers and personnel must satisfy in order to perform both the maintenance and the airworthiness review<sup>14</sup> prior to renewing the certificate of airworthiness of ultralight aircraft. Until said draft law is published, this Commission believes it necessary to issue a safety recommendation to the DGAC that it take into consideration the need to regulate this aspect.

3 – Since the airworthiness certificate renewal was mainly based in the report, presented by Aerosevilla Mantenimiento de Aeronaves, which documented the maintenance tasks performed during the last overhaul of the aircraft, and viewing

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<sup>14</sup> In the draft law, the airworthiness review would be equivalent to the overhaul of the aircraft prior to the renewal of the certificate of airworthiness.

that the engine maintenance was deficient, it is necessary for AESA to conduct an extraordinary inspection of Aerosevilla Mantenimiento de Aeronaves.

4- Lastly, a recommendation will be issued addressed to the leading association for amateur-built aircraft to carry out an information campaign among their members on the consequences of defective maintenance.



### **3. CONCLUSIONS**

#### **3.1. Findings**

- The pilot had a valid license and medical certificate.
- The aircraft's maintenance had been deficient. It had not been preserved during the long time it was parked. Automotive oil was used instead of aviation oil, which the manufacturer recommends. An oil filter was used that was not recommended by the manufacturer. What is more, the revision of the engine should have detected certain deficiencies that made the aircraft not airworthy.
- AESA renewed the aircraft Airworthiness Certificate based on the overhaul carried out by the maintenance company hired by the pilot.
- The day of the accident the aircraft had two additional fuel tanks in the wings, one to each side. This configuration was not according to the features sheet adhered to the Airworthiness Certificate.
- The investigation cannot determine if the fuel system modification was carried out prior to the renewal of the Certificate of Airworthiness due to the declarations of the pilot and the mechanic differ with respect to the moment in which it occurred, additionally there is not any maintenance record regarding when it was modified
- The aircraft took off with a weight which exceeded the maximum certified.

#### **3.2. Causes/Contributing factors**

The investigation has concluded that the likely cause of this accident was the execution of an off-field emergency landing in a crop field, required due to an engine that had overheated because of faulty maintenance.

#### 4. SAFETY RECOMMENDATION

The following safety recommendations are issued to AESA:

1 – AESA has established a procedure for renewing the Certificate of Airworthiness of amateur-built aircraft in which, as a general rule, the aircraft is to be physically inspected prior to each renewal (to include a flight test if possible). The CIAIAC believes that a physical inspection is always necessary to determine if the aircraft is airworthy or not; as a result:

**REC. 11/18.** It is recommended that AESA amend its procedure for renewing the Certificate of Airworthiness of amateur-built aircraft such that a physical inspection of the aircraft is always conducted prior to renew or issuing a certificate of airworthiness, and also to write down all the concrete tasks performed during that inspection, and the aircraft elements inspected.

2 – In order to renew the certificate of airworthiness, the Order of 31 May 1982 requires an overhaul of the aircraft, except for that aviation material or equipment that has its own potential. Neither the national nor the European regulations specify what maintenance centers or personnel are authorized to overhaul amateur-built aircraft. However, the DGAC and AESA are working on a draft regulation that will specify the requirements that maintenance centers and personnel must satisfy in order to perform both the maintenance and the airworthiness review prior to renewing the certificate of airworthiness of ultralight aircraft. Until said draft law is published, the following recommendation is issued to the DGAC:

**REC. 12/18.** It is recommended that the DGAC adopt the necessary regulatory changes proposed by AESA so as to establish the requirements that centers and associated personnel must satisfy to maintain and review the aircraft airworthiness of amateur-built aircraft.

3 – Given the fact that the airworthiness certificate renewal was mainly based in the report, presented by Aerosevilla Mantenimiento de Aeronaves, which documented the maintenance tasks performed during the last overhaul of the aircraft, and viewing the deficient maintenance performed on the engine of the accident aircraft, the following recommendation is issued:

**REC. 13/18.** It is recommended that AESA conduct an extraordinary inspection of Aerosevilla Mantenimiento de Aeronaves.

4- Lastly, it is considered necessary that the sector be aware of the consequences of a deficient maintenance, and thus:

**REC. 14/18.** It is recommended that the Asociación de Aviación Experimental carry out an information campaign among its members to raise awareness of the potential consequences of defective maintenance on their aircraft.

Although no operational safety recommendations are made, it is necessary to note that the lack of specific technical documentation for amateur-built aircraft, such as flight and service manuals, and also the technical documents necessary for its buying and selling, especially when there is a change of ownership involving said aircraft, could entail a risk to aviation safety, as the owners would be unaware of the specific performance characteristics of the aircraft they are piloting.