CIAIAC

COMISIÓN DE
INVESTIGACIÓN
DE ACCIDENTES
E INCIDENTES DE
AVIACIÓN CIVIL

# Report A-001/2018

**Accident involving an NG4 UL SPEEDY aircraft, registration EC-XGM, at the aerodrome of La Axarquía Vélez-Málaga (Málaga) on 4 January 2018**

GOBIERNO DE ESPAÑA
MINISTERIO DE FOMENTO

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Secretaría General Técnica

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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.

# CONTENT

# Abbreviations

| | |
|---|---|
| º ' " | Sexagesimal degrees, minutes and seconds |
| ºC | Degrees centigrade |
| AAE | Asociación de Aviación Experimental (Experimental Aviation Association) |
| AEMET | Spain's National Weather Agency |
| AENA | Aeropuertos Españoles y Navegación Aérea |
| AESA | Spain's National Aviation Safety Agency |
| APP | Approach control |
| ARO | Air traffic services reporting office |
| bar | Unit of pressure |
| EGT | Exhaust gas temperature |
| ft | Feet |
| h | Hours |
| hp | Horsepower |
| kg | Kilograms |
| km | Kilometers |
| km/h | Kilometers/hour |
| kt | Knots |
| l , l/h | Liters, Liters/hour |
| LAPL | Light aircraft pilot license |
| LEAX | ICAO code for the aerodrome of La Axarquía (Vélez-Málaga) |
| LEMG | ICAO code for the Málaga Airport |
| m | Meters |
| Mhz | Megahertz |
| m/s | Meters/second |

| | |
|---|---|
| m2 | Meters squared |
| METAR | Meteorological aerodrome report |
| N | North |
| W | West |
| rpm | Revolutions per minute |
| PPL | Private pilot license |
| PTM | Position reporting point for Torre del Mar (Málaga) |
| PV | Position reporting point for Embalse de Viñuela (Málaga) |
| SAR | Search and rescue |
| SEP | Single-engine piston rating |
| TORA | Takeoff runway available |
| UTC | Coordinated universal time |
| VFR-VMC | Visual flight rules – Visual meteorological conditions |
| Vne | Never-exceed speed |
| Vs | Stall speed |

## Synopsis

| | |
|---|---|
| Owner and Operator: | Private |
| Aircraft: | NG4 UL SPEEDY, registration: EC-XGM |
| Date and time of accident: | Thursday, 4 January 2018 at 09:30 LT |
| Site of accident: | Aerodrome of La Axarquía, Vélez-Málaga (Málaga) |
| Persons on board: | 1 crew - uninjured |
| Type of flight: | General aviation – Private |
| Phase of flight: | En route |
| Flight rules: | VFR |
| Date of approval: | 7 June 2018 |

### Summary of event:

On Thursday, 4 January 2018, an NG4 UL SPEEDY amateur-built aircraft, registration EC-XGM and S/N 10008-2479, suffered an accident in the vicinity of the aerodrome of La Axarquía, in Vélez-Málaga, located in the province of Málaga.

During the flight the engine stopped, which forced the pilot to make an emergency landing in a field near the threshold of runway 30 at the airport.

The pilot was not injured and exited the aircraft under his own power.

The aircraft sustained significant damage.

The investigation of the event has determined that the accident resulted from making an emergency off-field landing after the engine stopped during the flight due to a lack of lubrication.

The following factor contributed to the accident:

- The improper design by the installer of the layout of the lubrication system oil lines and their attachment to the exhaust.

The report contains a safety recommendation for AESA, as the authority responsible for issuing the aircraft's initial and continuing airworthiness certificate, and another for the AAE, to have it inform its members of the lessons learned from this investigation.

# 1. FACTUAL INFORMATION

## 1.1. History of the flight

On 4 January 2018, at around 09:30 local time, the pilot of an NG4 UL SPEEDY aircraft, registration EC-XGM, who was also its builder and owner, prepared to make a local VFR flight to and from the aerodrome of La Axarquía (Vélez-Málaga).

He filled the fuel tanks and did the pre-flight inspection, which revealed no problems with the aircraft.

He reported entering runway 12 for takeoff on the aerodrome frequency and took off without incident.

He climbed to about 6500 ft and, four or five minutes into the flight, noticed a sudden decrease in oil pressure.

After leveling out at 3500 ft, he informed another traffic at the aerodrome that he was returning to the field due to a problem. Given his position, the pilot decided to land on runway 30, which was closest.

As he was about 1000 ft over a nearby highway, en route to runway 30, the engine stopped so he decided to make an emergency landing on an avocado field next to the runway


Photograph 1. Accident aircraft at the impact site

## 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 as a result of the accident:

- Landing gear: destroyed.
- Wings: warped, bent and cracked.
- Propeller: two of the three blades, broken.
- Nose fairing: dented and scratched.
- Engine: irreversibly damaged.

## 1.4. Other damage

The damage to third parties was limited to four avocado trees in the private plantation where the crop was planted and in which the aircraft crash landed.

The trees were damaged as a result of the emergency landing carried out by the aircraft and its subsequent impact with and stoppage on the terrain.

## 1.5. Personnel information

### *1.5.1. Pilot*

The pilot, a 61-year-old Spanish national, had the following pilot license issued by Spain's National Aviation Safety Agency (AESA):

- Private pilot license (PPL) since 8 September 2011, with an SEP (land) rating valid until 30 September 2019.

He had class-2 and LAPL medical certificates that were valid until 4 February 2018 and 4 February 2019, respectively.

The pilot in command was the builder and owner of the accident aircraft.

According to information provided by the pilot, his total flight experience, including flight hours in ultralight aircraft, was 700 hours, 440 of which had been on the type of accident aircraft.

## 1.6. Aircraft information

### *1.6.1. General information*

The aircraft, an NG4 UL SPEEDY aircraft, is a low-wing monoplane with a fixed tricycle landing gear with fairings on all the wheels.

The design is by the company ROKO AERO, A.S., from the Czech Republic, and the pilot/owner built the aircraft using a kit available on the market.

It is designed for VFR and VMC flights.

The accident aircraft was equipped with an optional ballistic parachute.

The general characteristics of the aircraft, in compliance with the specification sheet issued by AESA on 21 March 2011, reference #10008-2479, are as follows:


Photograph 2. Accident aircraft in flight


Figure 1. NG 4 UL aircraft

**Structure:**

- Wingspan: 8.13 m
- Length: 6.45 m
- Surface area: 10 m2
- Maximum height: 2.28 m
- Empty weight: 292 kg
- Maximum takeoff weight: 600 kg *(This is the weight specified on the AESA certification data sheet, although the weight recorded in its registry database is 450 kg. This difference is presumably due to a typographical error in said database, and means the aircraft is not an ultralight)*
- Fuel capacity: 90 l
- Cargo capacity: 20 kg (baggage)
- Climb speed: 3 m/s
- Never-exceed speed (Vne): 270 km/h
- Average cruising speed: 214 Km/h
- Stall speed (Vs): 80 km/h

**Powerplant:**

ROTAX 912 ULS piston engine, S/N: 5,650,652. Characteristics:

- o Four-stroke, four horizontally opposed cylinders and dual ignition system
- o Starter: electric
- o Air-cooled cylinders and water-cooled heads
- o Maximum takeoff power at 5800 RPM: 100 hp
- o Continuous power at 3200 RPM: 70 hp
- o Consumption at maximum power: 28 l/h
- o Integrated gearbox with 2.4286:1 reduction ratio
- o Displacement: 1352 cc

**Instrument panel:**

**Propeller:**

- KASPAR S.R.O. wood/composite propeller:
    - Three-bladed tractor propeller with variable pitch in flight at constant engine RPM
    - Diameter: 1.68 m

**Fuel:**

- Type of fuel authorized and used: 95-98 octane gasoline
- The aircraft has two 45-l tanks, one per wing, for a total capacity of 90 liters, 5 of which is unusable.
- On the day of the event, the tanks were filled at the aerodrome with 95-octane gasoline.

**Lubricant:**

- Type of lubricant: AeroShell 4T SAE 05-50
- Tank: wet sump
- Capacity: 3 liters.

During oil changes, 30 to 50 turns of the propeller are required (depending on the installation) to generate the oil pressure needed for the oil to flow through the entire system.

### *1.6.2. Maintenance record*

This aircraft was built by the owner in 2010, with serial number 10008-2479. The aircraft was maintained by the pilot/owner as per the Maintenance Program authorized by the National Aviation Safety Agency on 25 January 2011.

The different kind of inspections required according to the mentioned program are as follows::

- Basic inspections every 50 hours
- Periodic inspections every 100 hours or 12 months
- Overhauls every 200 hours or 24 months

The airframe is checked at the same time as the engine, except for the overhaul of the engine, which is done every 200 hours or 24 months.

At the time of the accident, the aircraft had logged a total flight time of 440 hours 58 minutes, and the engine 471 hours 12 minutes. The last flight log prior to the accident was for a flight to and from the aerodrome of La Axarquía on 31 December 2017, which lasted a total of 18 minutes, including a 6-minute warm-up on the ground.

As for the engine, according to its log book, dated 23 February 2011, it was purchased on 15 October 2010 with a total of 63 hours. At the time of the accident, it had 471 hours 12 minutes, which correspond to the total number of hours of runtime through 31 December 2017, when the last flight was entered in the log book.

The last maintenance check of the engine was done on 14 April 2017 with 419.36 flight hours on the engine. It was a periodic 100-h, or annual, inspection, during which the oil and oil filter were changed, as well as the roller clutch.

The previous maintenance check of the engine was done on 25 February 2017, with 412 flight hours on the engine. It was a 200-hour or 24-month overhaul. No deficiencies were noted.

### *1.6.3. Airworthiness status*

According to the record of active registrations of the National Aviation Safety Agency, the amateur-built aircraft, serial number 10008-2479 and registration EC-XGM, was registered on 12 November 2010, with registry number 8864. The registration certificate listed the Toledo airfield as the aircraft's usual parking location.

The aircraft logbook was issued on 23 February 2011.

The aircraft had a Special Restricted Certificate of Airworthiness, No. A-1414, issued by the National Aviation Safety Agency on 7 April 2011, as a "Private-3-Normal"[1] category airplane. It was renewed on 28 April 2017 and was valid until 27 April 2019.

The aircraft also had the following authorization:

- Aircraft station license issued by AESA on 25 January 2011, which included the COM 1 (Garmin SL40) and transponder (Garmin GTX 330) units.

## 1.7. Meteorological information

### *1.7.1. General situation*

At low levels, there was an Atlantic high-pressure area zonally elongated from the Azores to the southwest of the peninsula, while at high altitudes there was a group of squalls. This configuration resulted in an intense pressure gradient over the north and east of the peninsula and the Balearic Islands (with a low-pressure trough present on the Mediterranean coast).

### *1.7.2. Situation in the accident area*

According to information provided by AEMET, the weather situation in the vicinity of the aerodrome of La Axarquía at 08:30 UTC was as follows:

- The temperature and rainfall station in Vélez-Málaga indicated a temperature of 12° C, 74% humidity and no precipitation.
- Just over 5 km away, the automatic weather station in Algarrobo indicated a temperature of 10° C, 88% humidity and wind from the east (070°) at 2 km/h, gusting to 5 km/h.
- In Nerja, a little over 25 km away, the temperature was 14° C, humidity 68% with no wind.
- At the Málaga airport, just over 30 km away, the 08:30 UTC METAR was: METAR LEMG 040830Z 28019KT CAVOK 15/08 Q1028 NOSIG

Satellite images revealed few clouds.

[1] Categories: Private (type of flight made by the aircraft); 3 (aircraft used only for visual flight); Normal (does not allow acrobatic flights or spins).

Therefore, the weather conditions were not limiting to visual flight.

## 1.8. Aids to navigation

The flight took place under VFR.

## 1.9. Communications

The communications are not available. Only the accounts from the pilot and eyewitness detailed in sections 1.16.1.1 and 1.16.1.2 were available..

## 1.10. Aerodrome information

The aerodrome of La Axarquía - Leoni Benabu (LEAX) is a private, restricted-use aerodrome in Spain with no control service that is located in the town of Vélez-Málaga (province of Málaga). The aerodrome is owned and run by the Real Aeroclub de Málaga. It is used exclusively for sports aviation and it only operates under VFR.

Its geographic coordinates are N 36° 48′ 08′ and W 4° 08′ 13″.

It has one 20-m wide asphalt runway in a 12/30 orientation with a TORA length of 959 m and 637 m, respectively. It is at an elevation of 120 meters above sea level. Its assigned air/air communications frequency is 123.5 MHz.

The air traffic services reporting office (ARO) assigned is Málaga (LEMG) and the position reporting points are Torre del Mar (PTM) and the Viñuela reservoir (PV). All aircraft not based at the aerodrome must request clearance to land at the aerodrome from its owner, the Real Aeroclub de Málaga.

Its operating procedures provide the following instructions:

- Flying without a radio is prohibited.
- Aircraft in the traffic pattern have priority.
- Report entering the aerodrome’s traffic pattern, and the downwind, base and final legs.
- The runway or either of its extended centerlines cannot be crossed without first reporting this on the air/air frequency (123.5 MHz).
- Aircraft flying over the aerodrome will report their intentions and altitudes on the air/air frequency (123.5 MHz).

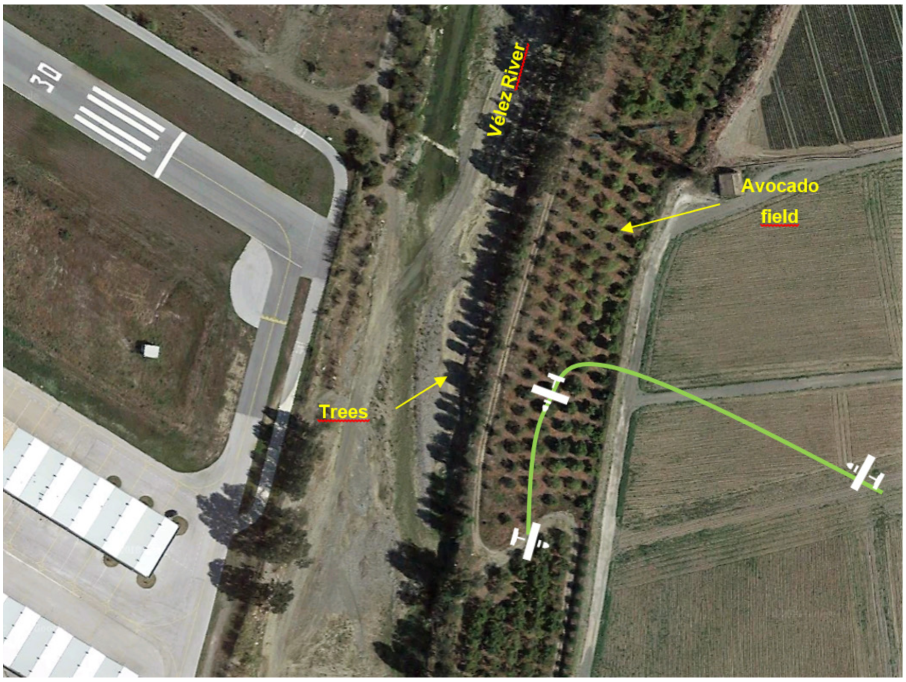
When an aircraft is going to hold over La Axarquía or inside the Seville control area at altitudes below 3500 ft, it is the pilots' own responsibility to provide for their own separation from other aircraft flying in the same pattern.

## 1.11. Flight recorders

The aircraft was not equipped with a flight data recorder or a cockpit voice recorder since the aviation regulation in effect does not require this type of aircraft to have any such recorders.

## 1.12. Wreckage and impact information

The aircraft's flight path during the emergency landing, based on the pilot's statement, is provided in Photograph 3, which shows the field of avocado trees close to and perpendicular to runway 30, where the aircraft impacted the ground.




Photograph 3. Accident site and aircraft's flight path

The aircraft came to a stop at coordinates N 36° 47′ 54″ W 4° 7′ 46″.

As it flew over the avocado field, the aircraft destroyed four avocado trees spanning some 200 m, eroding the surface of the terrain.

No debris from the aircraft was found in the area. The landing gear was destroyed and had detached, but was located in practically the same place where the aircraft stopped.

The aircraft sustained significant damage. During the visual inspection of the wreckage, this damage was identified as follows:

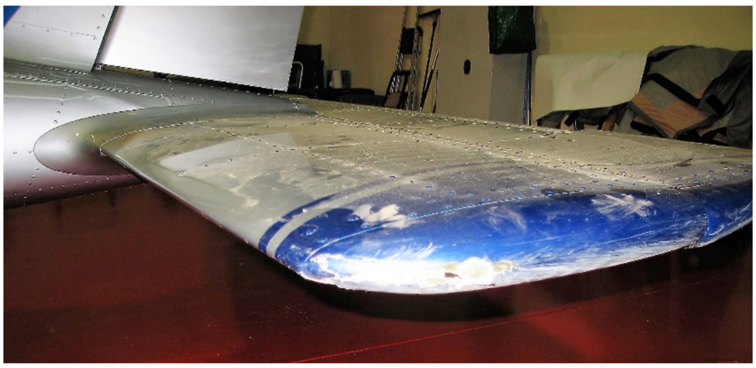
- Main and nose landing gear, destroyed and detached. Photographs 4 and 5.

- Wing bent: impacts to the leading edges and deformation at the roots. The right wing was bent at the root and an opening was found in structure of the left wing near the wingtip. Photographs 6 and 7.

- Horizontal stabilizer: dents on the leading edge near the root and abrasions on the ends of the stabilizer. Photographs 8 and 9.


Photographs 4 and 5. Detached main and nose landing gear


Photographs 6 and 7. Right and left wings

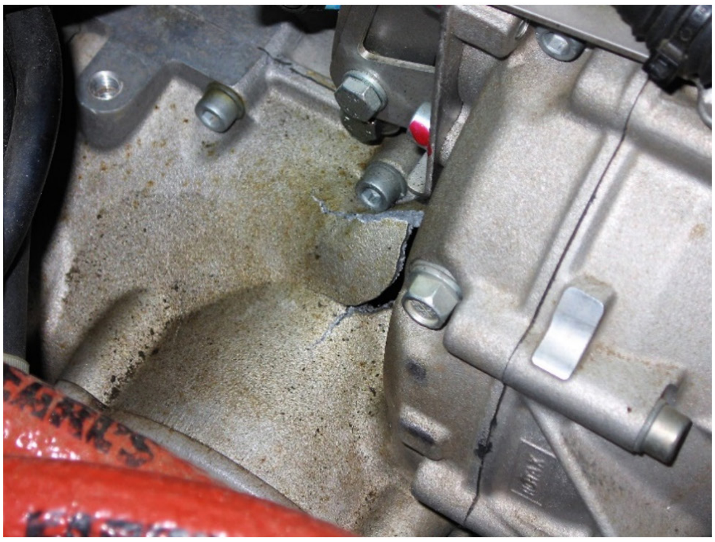



Photographs 8 and 9. Horizontal stabilizers: damage on left and right sides.

- Nose of the airplane: lower fairing deformed and propeller damaged, with two blades broken. Photograph 10.

- Engine: fracture in body of cylinder 1 and various dents at the bottom of the engine, radiator and air intakes. Photograph 11.

Photograph 10: Damaged nose and propeller



Photograph 11. Fracture in engine body

## 1.13. Medical and pathological information

The pilot was not injured and was able to exit the aircraft under his own power, though as a precautionary measure, he was taken to a nearby hospital for an examination.

## 1.14. Fire

Not applicable.

## 1.15 Survival aspects

The pilot was able to exit the aircraft under his own power. The cockpit structure retained its shape and sustained no deformations that could affect the pilot.

The safety harness performed properly. Its attachment points were in good condition.

## 1.16. Tests and research

### *1.16.1. Statements*

### *1.16.1.1 Pilot's statement*

On the day of the event, after the pre-flight inspection of aircraft EC-XGM and filling the fuel tanks, the pilot prepared to go on a local flight to and from the aerodrome of La Axarquía.


Figure 2. Visual approach chart for the aerodrome of La Axarquía

He informed other pilots on the local frequency that he was entering runway 12 to take off, which he did normally.

He climbed to about 6500 ft and four or five minutes into the flight, he noticed a problem with the oil pressure, which was suddenly dropping.

After leveling at about 3500 ft, he informed another aircraft at the aerodrome that he was returning to the airfield due to an oil pressure problem. After giving his position, the pilot decided to return via runway 30, which was the closest.

While it was about 1000 ft over a nearby highway, en route to runway 30, the engine stopped. Given his low altitude, he decided to make an emergency landing on a nearby avocado field. In order to line up with the furrows in the field and expedite the landing, he turned left and leveled off the aircraft; however, the left wing impacted an avocado tree, making the aircraft turn to that side and fall to the ground.

### *1.16.1.2 Statement from an eyewitness*

On the day of the event, another pilot was preparing to go on a local flight at about 09:30 local time. When he reported his intention to enter the runway and backtrack[2] to the runway 12 holding point, the pilot of aircraft EC-XGM informed him that he was at the holding point but that he could backtrack nonetheless, since there was room for two.

[2] Backtrack: term used to express taxiing on the runway in the opposite direction to proceed to the threshold

Once he reached the holding point and reported "runway clear", EC-XGM reported entering runway 12 to take off, which it did normally.

As he was doing the pre-flight checks, EC-XGM reported that it was reaching point PTM and transferring to the Málaga APP frequency. He finished his checks and took off normally.

Three or four minutes after taking off, the pilot of EC-XGM reported he was returning to the field due to an oil pressure problem and that he was heading directly to the runway 30 threshold, since it was closest. He informed him of his position and that he was turning right to clear the approach to runway 30. He asked him about his position, and the pilot of EC-XGM reported he had just passed the highway. He then saw him at his 11 o'clock, no more than half a mile away at the same altitude, about 1000 ft.

After crossing paths, he decided to follow him to make sure he could land normally.

When he turned he lost EC-XGM from sight, but then saw him again on final for runway 30 at a very low altitude. He saw him turn left and level the aircraft, lining up his flight path with the rows of avocado trees. The left wing impacted a tree, which made the airplane turn in that direction as it crashed to the ground.

He changed his frequency to Málaga APP to report the accident and the aircraft's position so they could inform emergency services. He then tuned to the LEAX frequency and made the same report.

He circled over the accident site in an effort to ascertain the situation. He saw someone next to the aircraft, but he did not think it was the pilot, since the cockpit was still closed.

He climbed a little to improve his coverage and again contacted Málaga APP to make sure they had received the message and that emergency services had been notified.

He tuned into the aerodrome frequency, where he contacted personnel from the aero club and reported the position of the accident aircraft and identified the most suitable route for emergency services to access the accident site. After flying the usual pattern, he landed without incident.

Upon reaching the stand, he again contacted aero club personnel, who confirmed that the accident pilot was in good condition.

*1.16.1.3 SAR and Civil Guard reports*

On the day of the event, the Madrid Rescue Coordination Center informed the CIAIAC that an accident had been reported to the 112 number in Andalusia, that the pilot was not injured and that the aircraft was in the custody of the Civil Guard on private property at the runway 30 threshold at the aerodrome of La Axarquía (LEAX).

The Civil Guard also told the CIAIAC that AENA had informed it of the accident, stating that the aircraft was on private property and that the pilot, although he had exited the aircraft under his own power, had been taken to the county hospital due to back trauma. The forensic police of Vélez-Málaga also reported to the scene to cordon off the aircraft.

### *1.16.2. Information on the takeoff operation based on engine parameters*

Given the characteristics of the event and the pilot's statement, investigators deemed it important to gather information on the takeoff operation from the standpoint of the engine parameters, at least those that have to be considered in order to safely operate the aircraft and ensure the proper operation of the engine.

Before taking off, the engine has to be warmed up. Initially this involves running it at 2000 rpm for approximately 2 minutes. The engine is then revved up to 2500 rpm for a length of time that will depend on the ambient temperature, but it should be sufficient for the oil temperature to reach 50° C.

The increases in engine speed are only allowed if the oil pressure reading remains at around 2 bars and the oil temperature at around 50° C.

According to the operating manual published by the engine manufacturer, if the engine is operating correctly, the oil pressure should rise after no more than 10 seconds have elapsed. The accelerator is then adjusted until a constant speed of approximately 2500 rpm is reached.

During takeoff, the engine speed is limited to 5800 rpm for a maximum of 5 minutes.

During cruise, the engine is normally kept at approximately 5500 rpm.

As for the standard oil pressure, it should be 0.8 bar below 3500 rpm and 2 to 5 bar above 3500 rpm.

Also of interest, given the relative positions of the exhaust and lubrication systems, is an analysis of the exhaust gas temperature (EGT). This temperature is displayed in the cockpit and its values are specified by the engine manufacturer in its installation manual, with a normal value being around 800º C and the maximum value being 850º C.

### *1.16.3. Recommended engine maintenance*

As concerns the lubrication system, an analysis of which was deemed to be of interest to the investigation, the engine manufacturer recommends that during the periodic visual inspections (which are required every 100 h), the oil supply lines be checked to identify potential leaks, hardening due to heat, porosity, and to check that the connections are tight.

The lines must be verified to be free from compression and from contact with undesired heat sources. The filters should also be checked, and the oil pressure sensor should be verified to be correctly adjusted and in good condition.

According to the engine manufacturer, if oil is being lost and the oil pressure remains below the minimum operating range for longer than 1 minute, the engine will be irreversibly damaged and may come to an uncommanded stop due to seizing of moving components.

The low oil pressure may also be due to a lack of oil in the oil tank. As a result, in addition to checking the level in this tank, the manufacturer recommends doing a check to make sure that the oil return line is not clogged.

### *1.16.4. Engine installation*

Since this event involved an amateur-built aircraft, it was deemed relevant to the investigation to consider the information provided by the builder regarding the options and recommendations for installing the various components.

The manufacturer of the aircraft kit does not include in its manuals any pre-flight, emergency or service checklists for the aircraft. It only provides the engine manufacturer manuals for the operation, maintenance and installation of the engine, but never as these pertain to a specific installation on various types of aircraft.

According to the engine installation manual, the engine block lets installers choose from two connection points for the oil lines, depending on the aircraft's configuration. In either case, and as a general rule, the point that allows for the shortest layout of the lines and the most secure connections, free from nearby heat sources or constrictions, should be used.

Figure 3 shows these two intake connections at the bottom of the engine, labeled “Pos. 1” and “Pos. 2”. The engine’s design is intended for a conventional, not acrobatic, layout, with the connection for the oil return line in the ideal position for an engine configuration with a tractor propeller (position 1) or a pusher propeller (position 2). This way, the engine manufacturer ensures that the engine will be properly lubricated in all flight profiles.

The appropriate connection must be made depending on the propeller configuration and/or the layout of the lubrication system, based on the information provided by the engine manufacturer.

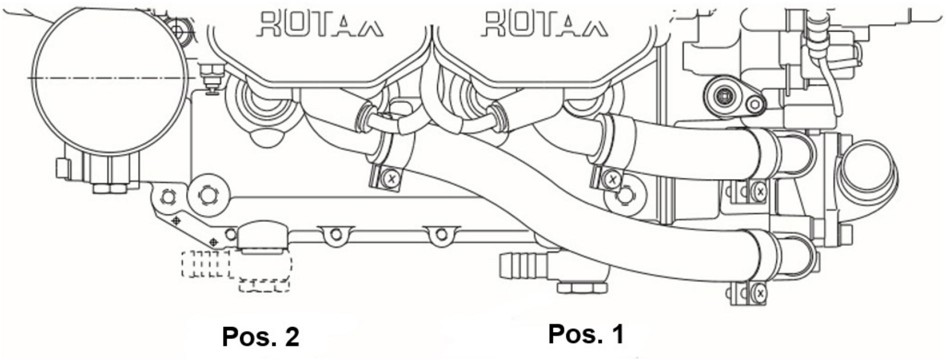



Figure 3. Positions of the connections for the oil return line

According to the installation manual, the layout of the engine piping, and specifically the oil and purge lines, must satisfy the following requirements:

- Oil lines – installed in the lubrication, engine and oil pump system:
    - A properly maintained line must be able to withstand a temperature of at least 140° C.
    - A properly maintained line must be able to withstand a minimum pressure of 10 bars.
    - It must have a minimum bending radius of 70 mm.
    - The minimum inner diameter of the lines, in relation to the total length, must be:

- minimum inner diameter of 11 mm for lengths up to 1 m.
- minimum inner diameter of 12 mm for lengths up to 2 m
- minimum inner diameter of 13 mm for lengths up to 3 m

o The maximum length per oil line is 3 m.

- Oil tank purge line: avoid sharp bends or folds.

### *1.16.5. Engine lubrication system*

The lubrication system on this type of engine is a forced lubrication system from the oil sump (see Figure 4). It has a main pump with an integrated pressure regulator

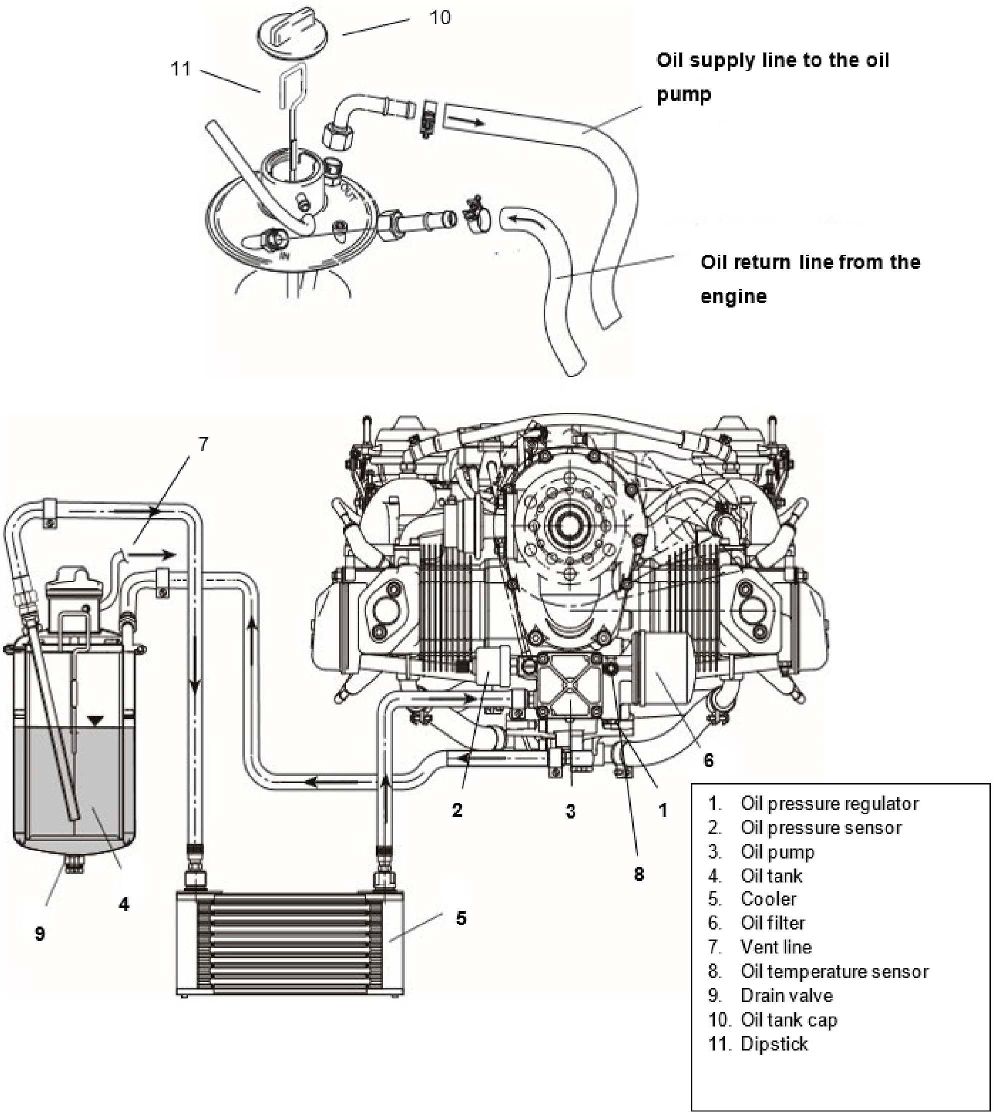


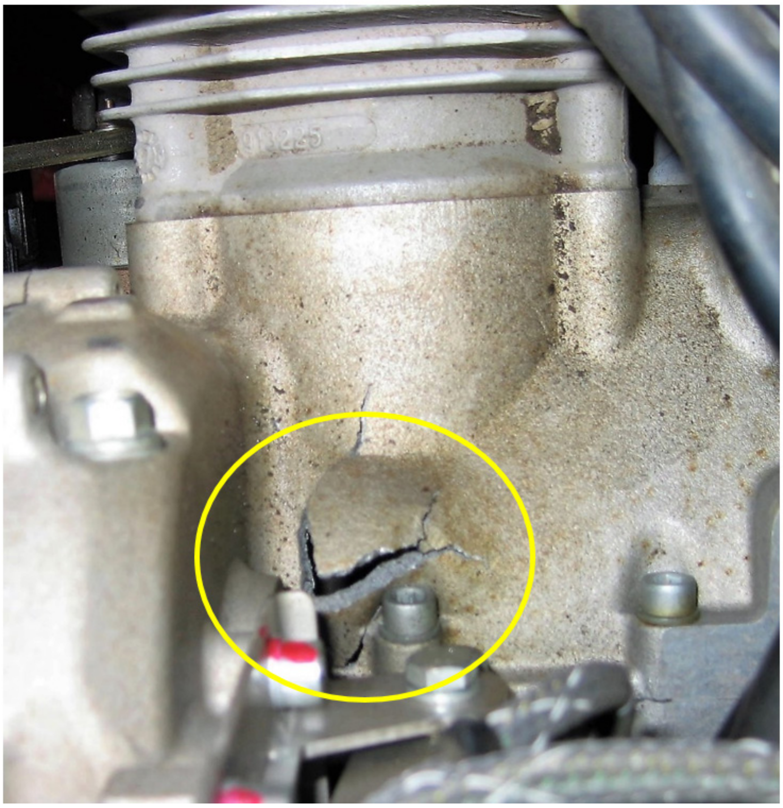

Figure 4. Lubrication system

(1) and an oil pressure sensor (2). The oil pump driven by the camshaft. The oil pump (3) draws a suction on the oil from the oil tank (4) via the oil cooler (5) and sends it through the oil filter (6) to the engine lubrication points. The excess oil emerges from the lubrication points at the bottom of the sump and returns to the oil tank, forced by the sump exhaust gases. The loop is vented through the tube (7) in the oil tank. There is an oil temperature gauge in the cockpit that takes a reading from the oil temperature sensor (8) located on the oil pump casing.

### *1.16.6. Inspection of the aircraft*

In light of the actions described by the pilot, as well as the accounts from the eyewitness, aerodrome personnel, etc., the aircraft underwent a thorough visual inspection once it was taken to the owner's hangar. Several engine components were also removed from the engine with help from specialized personnel from the engine manufacturer.

Several engine components and accessories specifically associated with the lubrication system were disassembled, as this system was deemed to have been related to the event based on the pilot's statement.



Photograph 12. Crack in the cylinder block

The engine cover was removed at the accident site, and it was subsequently moved to the hangar, where it was inspected. An examination of the engine block revealed a crack that penetrated from the inside of the #1 cylinder in the engine to the outside, as shown in photograph 12.

The oil tank was completely empty. The continuity of the lubrication system was verified. No oil was found in any part of the system.

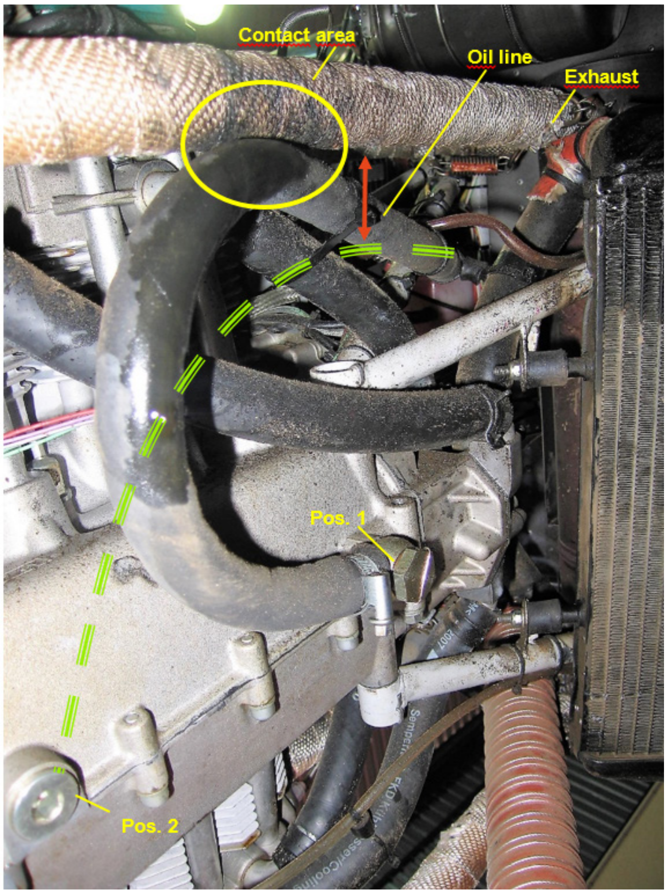
The oil filter was removed and cut to determine its internal condition. The filter material contained some golden metal particles, but no other type of contaminant or dirt was found.

The chip detector was also removed from the engine. As photograph 13 shows, there was a large number of large metal particles adhering to the detector.

The overall condition of the exhaust ducts was checked. It was noticed that they were attached to the engine mount via welding. There were no silent blocks.

Photograph 13. Chip detector block

The oil return line from the engine to the oil tank had been connected to position 1, of the two possible connections available (see Figure 3 and Photograph 14). The potential layout that could have resulted from using position 2, which would have been more suitable given the layout of the exhaust duct, is shown in green.




Photograph 14. Layout of the connection for the oil return line

The line was completely devoid of oil. Following its layout it was noticed that it was attached to other engine components using clamps and spacers.

The oil return line did not have any type of thermal protection. The exhaust lines, however, were protected with thermal tape.

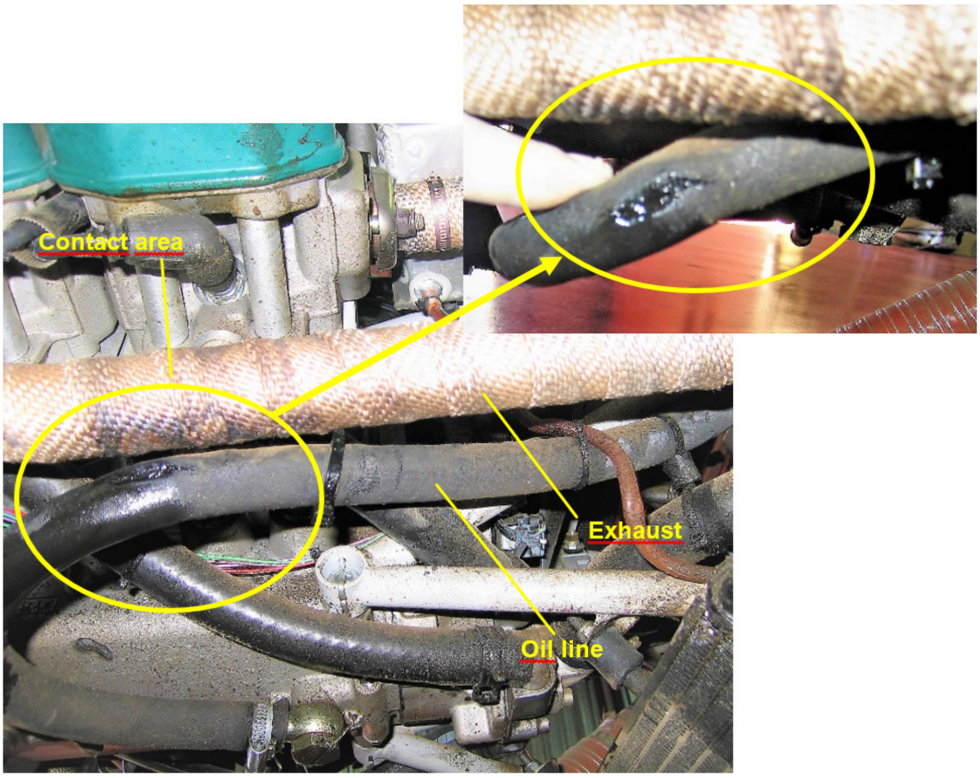
Near the engine inlet, one of the clamps securing the oil return line and one of the exhaust pipes was very loose. The two lines were touching one another.

According to the statement from the pilot and builder of the aircraft, the two lines were fastened using a plastic clamp and a spacer approximately 1 cm high (see Photograph 15).

The spacer was missing and the clamp provided over 1 cm of clearance.

An irregular longitudinal crack some 5 cm long was found in the oil line, and there were several burned oil stains on the exhaust collector (Photograph 15).

In general, there was residue from burned oil along the bottom of the engine and on the inside of the bottom engine fairing.




Photograph 15. Close-up of contact area identified between the oil return line and one of the exhaust ducts.

The expanded view shows the crack discovered in the oil return line in more detail.

## 1.17. Organizational and management information

Not applicable.

## 1.18. Additional information

Not applicable.

## 1.19. Useful or effective investigation techniques

Not applicable.

# 2. ANALYSIS

## 2.1. Analysis of the weather situation

The weather conditions in the area of the aerodrome of La Axarquía around the time of the event (09:30 local time) were not limiting to visual flight. No unexpected adverse conditions were identified that could have influenced the accident.

## 2.2. Analysis of the flight

According to the pilot's statement, during the pre-flight inspection he did not identify any problems indicative of a possible engine malfunction. He verified that the oil and fuel levels were adequate.

The engine pre-heat procedure was normal and attained an operating oil pressure of 0.8 bars.

Once the parameters required for takeoff were reached, the aircraft took off normally.

He climbed to about 6500 ft and four or five minutes later he noticed a problem with the oil pressure, which dropped suddenly below the operating limits.

The pilot, in keeping with the engine manufacturer's recommendations, correctly decided to make an emergency landing without delay. After experiencing a significant loss of power, he quickly descended to about 3500 ft and informed another aircraft at the aerodrome that he was returning to the airfield due to an oil pressure problem and that due to his position, he would do so using runway 30, which was closest.

Having lost power completely, and as he was flying over a nearby highway en route to runway 30, at an altitude of about 1000 ft and unable to reach the runway, he decided to make an emergency landing in a nearby avocado field.

In order to line up with the furrows in the field and avoid the trees so as to expedite the landing, he turned left and leveled off the aircraft. The maneuver was correct and it was properly executed, but due to the type of crop, the landing was rough and the left wingtip impacted an avocado tree, making the aircraft turn to that side and fall to the ground, collapsing the landing gear and bringing the aircraft to a final stop.

The aircraft's flight path during the emergency landing, based on the pilot's statement, is illustrated in Photograph 3, which shows how despite the pilot's initial intention to land on runway 30, he was unable to reach it. Given his low altitude, and in order to avoid impacting the row of trees perpendicular to the runway, he decided to turn left so as to line up with the rows in the field and expedite the landing.

The flight lasted a total of approximately 9 minutes.

The statements of the pilot and eyewitness, as well as the findings from the analysis of the aircraft wreckage and the tracks at the accident site, are consistent with the event and indicate that the proper course of action was taken. The pilot carried out the applicable emergency procedures and made the correct decisions to maximize the safety of the operation.

### 2.3. Analysis of the aircraft wreckage

The aircraft wreckage indicates that the aircraft's flight path during the landing was parallel to the rows in the crop field where the aircraft impacted, consistent with the pilot's statement.

The warping of the wings, with the dents identified on the leading edges, the right wing bent at the root, and the indentation on the left wingtip, serve to indicate the successive impacts that the aircraft endured with the avocado trees on the ground, its flight path aligned with the rows of trees and the various impacts that unbalanced the aircraft and made it turn left and crash to the ground, where it came to a stop. This impact is also consistent with the destruction of the landing gear, the detached remains of which were found with the fuselage with almost no scattering, as well as with the damage to the lower nose fairing and the broken propeller blades, caused when the aircraft's nose dug into the ground.

The loss of power and subsequent engine stoppage are consistent with the damage found on the propeller blades, which shows that at the moment of impact with the ground, the propeller was not rotating.

The small dents in the horizontal stabilizer were the result of scraping with the avocado trees as the aircraft flew a short distance over the ground before crashing into it, indicative of the low altitude and speed at which it was flying.

## 2.4. Analysis of the maintenance and operation of the engine

According to information provided by the pilot, who was the owner and builder of the aircraft, the engine installation and its connection to the aircraft's airframe, mounts, etc., as well as the installations and layouts of the lubrication and electrical systems, had not been modified at any point after the special restricted certificate of airworthiness was issued by the National Aviation Safety Agency on 7 April 2011. The certificate was renewed on 28 April 2017, when the engine had 50 hours fewer than at the time of the event, and was valid until 27 April 2019.

As recorded in the engine logbook, the only modification with respect to the original design and assembly was to the fuel lines, their connectors and clamps, which was made on 14 April 2016. Therefore, this was done prior to the renewal of the certificate of airworthiness on 28 April 2017, meaning this modification was authorized with the renewal.

The last maintenance check of the engine was done on 14 April 2017, with 419 flight hours 32 minutes on the engine. The check involved a periodic 100-h, or annual, inspection, during which the oil and oil filter were changed. There are no indications that any problems were identified with the oil system, its fasteners or connections. At the time of the event, the engine had 471 flight hours 12 minutes.

During the pre-flight inspection, the checks of the oil level and the fasteners on the lines and ducts did not reveal any potential wear on the spacer installed between the oil return line and the exhaust duct. If it had broken off at some point, this could be an indication that its condition was not properly checked prior to the accident flight. On this final flight, at least, the pilot should have noticed that either it was not present or that it was worn, since said wear was caused by the thermal stress to which it had been subjected over successive flights.

In any event, this spacer broke off, which loosened the clamp to which it was attached and allowed the two lines that were being held by it to move and come into contact.

The materials used in oil lines, especially those for aviation use, are synthetic rubbers, nitrile butadiene rubber that can withstand temperatures from -40° C to +108° C. The contact between the oil return line and the exhaust manifold, whose temperature was at least 800° C, caused the material to melt 9 minutes into the flight. This created a longitudinal gash in the hose through which the engine lubricating oil was lost during the flight. This is evidenced by the burned oil residue found on the components on the lower engine fairing, the exhaust ducts and the fairing itself.

The short duration of the flight was sufficient for the engine lubrication system to empty out through the crack caused by the overheating, as was noted during the inspection.

Considering how 30 to 50 rotations of the propeller are needed for the oil to flow through the entire system (depending on the installation), at a constant power of 3200 rpm (53.33 rotations per minute), one second would have allowed all the oil to exit the system, impeding lubrication.

The lack of oil left all moving parts of the engine without lubrication. The oil pressure dropped to zero and the 1-minute time limit was exceeded, which, according to the manufacturer, is the maximum length of time that an engine can be run without lubrication before it is irreversibly damaged.

Although the cylinder with the apparent crack was not disassembled, its location would indicate that the crack was caused by an impact from a connecting rod once its components seized.

The presence of metallic particles in the chip detector indicates the friction and wear to which the moving components in the engine were subjected due to the lack of lubrication. The presence of large chips also reveals that the engine seized quickly, which is consistent with the brief duration of the flight and the ensuing engine stoppage.

There were only a few of these particles in the oil filter, probably because they were expelled through the crack in the damaged oil line during the flight.

Since not enough oil was reaching the engine at the proper pressure, this improper lubrication caused the friction between components to generate so much heat that they seized. Some components may even have melted. The resulting wear, heat and expansion caused the engine to seize.

The seizing found in the engine block (see photographs 11 and 12) above the #1 cylinder is evidence of the extreme lack of lubrication, which caused one of the connecting rods to break.

## 2.5. Analysis of the engine installation

Given the two connections provided in the engine for installing the oil return line, it is obvious that the installer selected the worse option. He did not consider how the layout failed to satisfy the bending radius and length requirements specified by the engine manufacturer. More importantly, he did not consider the effect of overheating on the line through which all of the engine’s oil was lost due to the proximity between this line and the exhaust duct.

The installer wrapped the exhaust manifold in thermal tape in an effort to isolate surrounding components from the high temperatures reached in the manifold, believing that this insulation, and using a clamp and spacer to separate the oil line, would be enough to prevent damage from overheating. As the consequences of this accident have shown, these preventive actions were not enough. The high thermal stress experienced over time by the spacer caused it to break, leaving the clamp loose enough that the line was allowed to come in contact with the exhaust duct. This caused the line to rupture and the oil to leak out, which, as analyzed in the point above, resulted in the loss of lubrication to the engine, causing it to seize.

Even if the spacer had not broken on this occasion, since a) the oil return line was not thermally insulated, b) the clamp itself allowed both lines to move while the engine was running, resulting in contact at some other point, and c) there was very little space separating them along their respective runs, the effect of the high temperatures given off by the exhaust manifold could not have been avoided in any event.

The design of piping runs must ensure that even if clamps or spacers break, the likelihood of oil lines coming into contact with sources of engine heat that can damage them is as low as possible.

Since the engine allows for different configurations, the one that minimizes this risk must be selected by laying out the lines in a way that minimizes their lengths and either keeps them separated from hot areas that can damage them or employs good thermal insulation.

Attaching the exhaust to the mount using welds is also thought to be a defect in the design of the installation, since this entails the transfer of more heat to the entire assembly. The typical practice is to minimize this effect by using silent blocks, which were not installed in this case.

The installation was inadequate from the start, and this was apparently not identified when the certificate of airworthiness was issued, a certificate that implicitly approved the design of the layout and its installation.

# 3. CONCLUSIONS

## 3.1. Findings

- The aircraft's pilot had a valid private pilot license (PPL) with a single-engine piston (land) rating.

- His class-2 and LAPL medical certificates were valid.

- The pilot had a total of 700 flight hours, of which only 440 had been on the accident aircraft.

- The pilot was the builder and owner of the aircraft.

- The amateur-built aircraft was maintained by the pilot/owner.

- The aircraft had a valid certificate of airworthiness for the flight in question. This certificate was last renewed on 28 April 2017 and was valid until 27 April 2019.

- Since its initial issue, the certificate of airworthiness had been renewed without any changes having been made to the layout of the lubrication system lines or to the engine exhaust.

- The aircraft was built in 2010 and had logged a total flight time of 440 hours 58 minutes.

- According to AESA's registration registry, the aircraft had a maximum takeoff weight of 450 kg, which would classify it as an ultralight, but in fact its weight limit was 600 kg, as specified in the aircraft's certification data sheet.

- The last scheduled maintenance check of the engine was done on 14 April 2017, with 419.36 flight hours on the engine. It was a periodic 100-hr, or annual, inspection. During this check, the pilot changed the oil and oil filter and carried out other tasks not involving the lubrication system.

- An analysis of the pilot's response to the emergency situation revealed it to be adequate, not entailing any additional risk or damage.

- The weather conditions were not limiting to visual flight.

- The inspection and analysis of the aircraft wreckage revealed the presence of irreversible damage to the engine, which seized, as well as the fracture of the return oil line, which left the lubrication system without oil.

- The investigation determined that the design of the layout of the oil lines and the exhaust manifolds was not correct.

- The spacer between the oil return line and the exhaust manifold broke due to being subjected to high temperatures, causing these two components to come in direct contact with one another.

- The investigation also revealed that the oil return line broke due to overheating when it came into contact with the exhaust manifold at engine operating temperatures.

- The oil from the lubricating system was lost through the rupture in the engine oil return line.

- The lack of lubrication in the engine caused a connecting rod to break, which resulted in the engine stopping.

- The airworthiness certification did not identify the risks in the design of the lubrication system and engine exhaust layout.

- The pilot was not injured and was able to exit the aircraft under his own power.

## 3.2. Causes/Contributing factors

The investigation of the event has determined that the accident resulted from making an emergency, off-field landing after the engine stopped during the flight due to a lack of lubrication.

The following factor contributed to the accident

- The improper design by the installer of the layout of the lubrication system oil lines and their attachment to the exhaust.

## 4. SAFETY RECOMMENDATIONS

REC 32/2018: It is recommended that AESA ensure that the certificates of airworthiness issued to amateur-built aircraft include an inspection of the equipment integrated into the aircraft and its engines, in keeping with the installation recommendations and requirements of both the aircraft and engine manufacturers, so as to minimize the risks associated with an incorrect installation.

REC 33/2018: It is recommended that AAE (Asociación de Aviación Experimental) communicate to its members the results of this report for their knowledge so as to make them aware of the need to follow the recommendations and requirements laid out by the aircraft and engine manufacturers involving the installation of their various components.