FINAL REPORT
of civil aviation safety investigation

CLASSIFICATION

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accident</td>
<td></td>
</tr>
<tr>
<td>Owner</td>
<td>Private</td>
</tr>
<tr>
<td>Operator</td>
<td>Private</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>ATEC v.o.s. Czech Republic</td>
</tr>
<tr>
<td>Aircraft</td>
<td>Zephyr 2000</td>
</tr>
<tr>
<td>Registration country</td>
<td>Romania</td>
</tr>
<tr>
<td>Registration</td>
<td>YR-5202</td>
</tr>
<tr>
<td>Location</td>
<td>Iași South Aerodrome (LRIS)</td>
</tr>
<tr>
<td>Date and time</td>
<td>22.08.2018 / 18:30 LT (15:13 UTC)</td>
</tr>
</tbody>
</table>

No. : A19 - 03
Date: 30.01.2019
AKNOWLEDGEMENT

This REPORT presents data, analysis, conclusions and recommendations made by the Civil Aviation Safety Investigation Commission appointed by the General Director of AIAS.


The sole objective of civil aviation safety investigation is preventing the occurrence of accidents and incidents, by effective determination of causes and circumstances that led to this occurrence and establishing the necessary recommendations for civil aviation safety.

Civil aviation safety investigation does not establish guilty, individual or collective responsibilities.

As a consequence, the use of this REPORT for other purposes than preventing the occurrence of civil aviation accidents and incidents might generate misinterpretations.
ACCIDENT DURING EMERGENCY LANDING

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Zephyr 2000 ATEC / YR-5202</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date and time</td>
<td>22.08.2018 / 18:13 LT (15:13 UTC)</td>
</tr>
<tr>
<td>Operator</td>
<td>Private</td>
</tr>
<tr>
<td>Type of flight</td>
<td>Private flight</td>
</tr>
<tr>
<td>Persons on board</td>
<td>Pilot</td>
</tr>
<tr>
<td>Victims</td>
<td>N/A</td>
</tr>
<tr>
<td>Pilot-in-command</td>
<td>ULM license pilot, valid</td>
</tr>
<tr>
<td>Nature of damage</td>
<td>The aircraft suffered substantial damage: landing gear broken, two of the propeller blades broken, flaps damaged, Pitot tube plucked</td>
</tr>
<tr>
<td>Location</td>
<td>Iași South Aerodrome, north of runway 32</td>
</tr>
<tr>
<td>Coordinates</td>
<td>Latitude: 47°9’36.8998” N, Longitude: 27°37’57.9931” E</td>
</tr>
</tbody>
</table>

1. HISTORY OF THE OCCURRENCE

On 22.08.2018, being on Iași South Aerodrome (ICAO code - LRIS), the pilot, who is also the owner of the aircraft identified YR-5202, performed, according to his own statement, some maintenance work to the aircraft engine, as provided in the manufacturer’s manual. The work has been completed by conducting some ground tests to the engine, to check its parameters.

After finding that the engine parameters are in line with the values recommended in the maintenance manual, the pilot considered that a check in flight was also necessary. Thus, after preparing the aircraft for take-off, he got in contact with the control tower of Iași airport (ICAO code - LRIA) for flight coordination.

The take-off was normal, the pilot using the runway in service RWY32. The flight duration was of about 10 minutes, while the aircraft was functioning properly and the engine parameters were within the prescribed limits. After landing, the pilot stopped the engine and the aircraft stationed for about 15 minutes, during which he carried out engine checks, taking into account the fact that he had used various operating modes during the flight.

Finding that after the flight performed the engine had no problems, the pilot decided to perform another flight, using the same runway – RWY32 for take-off. Acceleration, detachment and initial climb were in normal parameters.

After the take-off, at a height of about 100 m, the aircraft, being still in the climb phase, started to vibrate, followed shortly by the loss of engine power.

Under these circumstances, the pilot decided to perform an emergency landing. Given the limited options available, the landing could not be safely performed, so it was forcibly performed at approximately 30 m from the aerodrome runway 14 threshold.
Coordinates of the accident site:

Latitude: 47° 09' 36,8998" N
Longitude: 27° 37' 57,9931" E

The aircraft suffered substantial damage: landing gear broken, two of the propeller blades broken, flaps damaged, Pitot tube plucked.

The pilot left the aircraft on his own forces and did not require medical care.
2. ADDITIONAL INFORMATION

2.1 Pilot information

<table>
<thead>
<tr>
<th>Pilot</th>
<th>Male, 48 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>License</td>
<td>ULM pilot license, valid</td>
</tr>
<tr>
<td>Medical certificate</td>
<td>1/2/LAPL classes, valid</td>
</tr>
<tr>
<td>Flight experience</td>
<td>Approx. 1400 hours on ULMs</td>
</tr>
</tbody>
</table>

The pilot of the aircraft also had the qualifications of instructor, examiner and inspector for ULMs.

2.2 Aircraft information

Zephyr 2000 is an ultralight two-seater, low-wing aircraft, manufactured by ATEC v.o.s. from the Czech Republic. Zephyr can be delivered fully assembled and equipped (ready-to-fly) or in kit form for assembly by the user (amateur construction). The landing gear is a fixed tricycle undercarriage with a steerable front wheel. The cabin is provided with two cockpit positions positioned „cote a cote“. The aircraft manufacturer recommends installing a ROTAX 912 UL (80 HP) or ROTAX 912 ULS (100 HP) engine.

The YR-5202 aircraft, serial number Z1460607S, has been delivered as a kit and it was assembled in 2008 by its owner. On the accident day, the aircraft had 1074:17 flight hours and 4730 landings.

The power-plant is a pull arrangement and consists of a ROTAX 912ULS engine of 100 HP, serial number 4428837, and a three bladed propeller. The engine was installed on the aircraft in 2014 and operated 220:17 hours until the day of the accident occurrence.

The aircraft and engine operation data are presented according to the owner records.
2.2.1 Records in aircraft and engine documents

In the Aircraft Log Book, both flight activity (number of take-offs and flight hours per activity day, and the total flight hours), as well as the maintenance work on the aircraft cells and systems, shall be noted in accordance with the requirements of the approved maintenance program.

According to Zephyr's *Operations and Maintenance Manual*, the engine maintenance is performed in accordance with the requirements of the engine manufacturer (BRP-ROTAX). It requires engine users to record the hours of operation in a special book dedicated to the engine (engine log-book). In this way, the maintenance intervals at which the prescribed works are to be performed are determined and the TBO (Time Between Overhauls) is calculated. TBO is indicated both in operating hours and in calendar time (years).

![Fig. 4 – Extract from the engine manufacturer's requirements](image)

Thus, for the ROTAX 912 ULS engine, the TBO is set at *1500 operating hours or 12 years, whichever of these two conditions comes first.*

![Fig. 5 – Limits imposed on the TBO](image)
The investigation commission requested information from the manufacturer about the engine series 4428837. Thus, according to ROTAX, the engine was manufactured in December 2002 and delivered in January 2003. After delivery, no repairs by a ROTAX Authorized Service Center have been recorded.

From the documents provided by the pilot, the investigation commission could not identify elements indicating the engine’s total operating time. In the aircraft logbook there is a record of the engine operating/flight hours only since the engine was installed on the aircraft.

On the date the engine was installed on the YR-5202 aircraft (09.09.2014), the pilot considered that the engine had 0 (zero) operating hours, although there were no documents to justify this.

There is no engine log or any other documents related to the history of the current maintenance / major overhaul or to the number of operating hours prior to installing the engine on the YR-5202 aircraft.

### 2.2.2 Engine fuel system

The ROTAX engine’s *Installation Manual* specifies:

- the design and installation of the fuel system from the tank to the inlet of engine-driven fuel pump is the responsibility of the aircraft manufacturer;

- the fuel system must ensure the engine fuel supply in all flight conditions at the flow and pressure required in the engine manual;

![The fuel system from tank to the inlet of engine-driven fuel pump has to be installed by the aircraft manufacturer.](image)

Fig. 6 – Fuel system requirements

The scheme of the fuel system recommended by the engine manufacturer is as follows:
In case of the YR-5202 aircraft, the fuel system consists of a built-in tank fitted on the fuselage, with a drain valve at the bottom. The fuel tank has a total capacity of 83 liters. The fuel tap is situated on the central console, having ON and OFF positions.
The pressure in the fuel supply circuit is indicated on board:

![Fuel pressure indicator](image)

**Fig. 9 – Fuel pressure indicator**

The investigation commission arriving on the accident site found that the electric pump and the fuel filter were positioned at the bottom of the engine compartment, between the firewall and the engine:

![Electric pump and fuel system filter](image)

**Fig. 10 – Electric pump and fuel system filter**

Samples of petrol from the aircraft fuel tank have been taken for expertise. The analysis showed that the petrol complies with the provisions of **SR EN 228 - Automotive fuels - Unleaded petrol norm**. The initial boiling point of the petrol used has a low value (41°C).

### 2.3 Aerodrome information

Iași South Aerodrome (LRIS) is authorized by the RCAA for daytime general aviation operations and VFR (Visual Flight Rules) flights. The runway is grassy, 650 m long and 45 m wide, with 14/32 magnetic heading.
2.4 Meteorological conditions

According to the weather report received from the Iași International Airport (LRIA), located in the immediate vicinity of the aerodrome, on the day and at the time of the accident occurrence the temperature was of 28°C, wind speed of 6 KT (3 m/s) from the North direction, clear sky with visibility over 10 km, without significant variations.

2.5 Analysis

According to the pilot’s statement, after the take-off, at a height of about 100 m, the aircraft, being still in the climb phase, started to vibrate, followed shortly by the loss of engine power, so that he decided to perform an emergency landing.

After a quick assessment, he found that there was a hill on the initial heading, an area with various buildings on the left side, and an area with various obstacles on the right side: electricity poles, airport runway approach lighting pillars, antennas.

Therefore, the solution chosen by the pilot was to perform a turn of about 30° to the left of the take-off direction, followed by another turn to return on the aerodrome’s runway 14. Given that the aircraft was in the take-off configuration (flaps 15°) and due to the lack of traction, and the descent being pronounced so as to maintain the speed, the turn could not be completed, the landing being forced, at approximately 30 m from the threshold of the aerodrome’s runway 14.

The pilot closed the fuel tap (fig. 8) situated in the cockpit at the moment he prepared for landing, which made the impact with the ground to occur with the engine stopped, this fact being confirmed also by the propeller damages: two blades broken, and the third blade undamaged.

![Fig. 11 – Propeller blades](image)

After the damaged aircraft has been transported to the hangar, it was checked by the investigation commission.
The damage caused to the aircraft has been noticed: landing gear broken, two of the propeller blades broken, flaps damaged, Pitot tube plucked. The engine inspection has been performed and it was found that it doesn’t show signs of hits or damage, but the following nonconformities have been noted:

- carburetor no. 1 – detached from the clamping strap, without being deformed or hit;
- exhaust manifold – detached from the fixing springs without deformations;
- fuel filter – displaced from the position it was installed, by the nose leg, which, on impact, has been detached from the fitting points on the fuselage.

No leakages (oil, petrol, coolant) were found, the oil land coolant radiators being intact (with no signs of hits and/or deformations).

Since the engine had no signs of hits or deformations, it has been decided to check the oil level, according to the Pre-flight check procedure from the Operations Manual BRP-ROTAX: thus, the oil tank shell was removed and the propeller was spun by hand for several times so as to pump the oil from the lubrication system back to the oil tank. By performing this operation, it has been found that the engine was running freely, without noise or internal resistance and had compression. The oil level was within the prescribed limits, and the oil didn’t contain impurities or foreign particles.

The spark plugs and their caps were disassembled and inspected – their condition was in line with normal operating conditions:

It was then checked the operation of the electric fuel pump – it was operating normally. The filter installed in the aircraft fuel system was also checked.
The BRP-ROTAX requirement for this filter: the filter mesh size to be of 0.1 mm:

<table>
<thead>
<tr>
<th>Filter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse filter</td>
<td>On fuel tank as per valid certification.</td>
</tr>
<tr>
<td>Fine filter</td>
<td>In the feed line from tank to the fuel pumps an additional fine filter with</td>
</tr>
<tr>
<td></td>
<td>mesh size 0.1 mm (.004 in.) has to be provided. The filter has to be</td>
</tr>
<tr>
<td></td>
<td>controllable for service. A combination of filter/water-trap (gascolator)</td>
</tr>
<tr>
<td></td>
<td>is recommended.</td>
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</tbody>
</table>

Examining the filter installed on the aircraft, the investigation commission found the following:
- based on the pilot’s statement, the filter was purchased from the internet and, according to its description, its filter mesh size is of 30 microns (0.03 mm) – being denser that that recommended by the engine manufacturer, which could have reduced the fuel flow;
- the shell in which the filter is located has a large volume and is made of a metallic alloy which could favor the heating of the fuel remaining inside;
- it was found that a pipe with an inner diameter smaller than the one specified by the engine manufacturer was installed between the filter and the electric pump;
- the electric pump and the fuel filter were positioned at the bottom of the engine compartment, between the firewall and the engine, an area that heats heavily during the engine running.

The filter mesh size, combined with the small size of the fuel pipe between the filter and the electric pump, could have contributed to lowering the manufacturer’s prescribed flow for a normal engine operation.

After the inspection of the engine and its systems was completed, the elements that had been detached were repositioned – carburetor no. 1 and exhaust manifold – the propeller was dismounted and a „cold” engine rotation was performed using the starter, without fuel supply. The engine rotated freely, without any noise or internal resistance.

Then the engine was started – it started and operated without any anomalies. Then it was stopped and checked – there was no leakage of liquids (oil, petrol, coolant).

After the checking operations have been completed with no evidence of nonconformities, a second engine start was performed, and this time the engine started and ran for about 3 minutes without anomalies.

Considering the place chosen for positioning the filter and the pump, the size and material of the filter shell, and the meteorological conditions in which the flights were performed on the accident day, the investigation commission considered that the most likely assumption of abnormal engine operation is the occurrence of the Vapour Lock phenomenon.

The Vapour Lock phenomenon occurs when the fuel aggregation state changes from liquid to gas, while it is in the supply system. This prevents the fuel pump to operate within its nominal parameters, causing the loss of supply pressure/flow, resulting in temporary loss of power or even complete engine shutdown.

Vapour lock can be formed when the engine is turned off without its prior cooling, the ambient temperature is high and the aircraft is parked for a short period of time (approximately 10-15 minutes). The fuel in the engine supply system doesn’t move and can thus heat enough to vaporize and cause the vapour lock.

This phenomenon is more common in petrol fuel systems that have a mechanical low-pressure fuel pump, operated by the engine, located in the engine compartment.

On this aircraft, the mechanical supply pump is placed higher than the fuel tank. The fuel being sucked under negative pressure from the fuel tank through the supply pipe, the risk of obstructing the supply pipe with fuel vapours between the tank and the pump increases.
The investigation commission considers that the main factors that could led to occurrence of the *vapour lock* phenomenon are as follows:

- high ambient temperature: 28° – 30° C;
- the engine was turned off without prior cooling;
- the initial boiling point of the petrol used is of low value;
- the dimensions and material of the fuel filter shell (facilitating the heating of fuel remaining inside);
- the area where the fuel filter and electric pump have been positioned – an area prone to heavy heating;
- short stationing time prior to performing the accident flight.

3. CONCLUSIONS

3.1 Findings

1. The pilot had a license for ultralight motorized aircraft and a medical certificate, both valid;
2. The pilot has also qualifications for instructor, examiner, and inspector for the ULM category;
3. During the take-off, after detachment, being still in the climb phase, the aircraft started to vibrate, followed shortly by the loss of engine power;
4. Given the limited options available, the landing could not be safely performed, so it was forcibly performed;
5. There is no engine log or any other documents related to the history of the current maintenance / major overhaul or to the number of operating hours prior to installing the engine on the YR-5202 aircraft;
6. In the aircraft log-book there is a record of the engine operating/flight hours only since the engine was installed on the YR-5202 aircraft (09.09.2014);
7. According to ROTAX, the engine series 4428837, installed on the YR-5202 aircraft, was manufactured in December 2002 and delivered in January 2003;
8. On the date the engine was installed on the YR-5202 aircraft, the pilot considered that the engine had 0 (zero) operating hours, although there were no documents to justify this;
9. The electric pump and the fuel filter were positioned at the bottom of the engine compartment, between the engine and the firewall, an area that heats heavily during the engine running;
10. The shell in which the filter is located has a large volume and is made of a metallic alloy which favors the heat transfer to the fuel remaining inside;
11. The mesh size of the filter installed on the aircraft is of 0.03 mm (30 microns), and the one recommended by the engine manufacturer is of 0.1 mm;
12. The fuel supply pipe installed between the filter and the electric pump has an inner diameter smaller than the one specified by the engine manufacturer;

13. The fuel sample taken from the fuel tank is compliant with the engine manufacturer’s requirements;

14. No nonconformities were found at the inspection of the spark plugs and their caps;

15. When spinning the propeller by hand, it was found that the engine rotates freely, without any noise or internal resistance, and has compression;

16. The oil level in the lubrication system was within the prescribed limits, and the oil didn’t contain impurities or foreign particles;

17. When rotating the engine „on cold”, it had a free rotation, without any noise or internal resistance.

18. The engine started and operated without any anomalies.

3.2 Probable cause of the accident occurrence

Limited options for performing a forced landing in safety conditions.

Contrbuting factor:

Loss of power during the initial climb due to the Vapor Lock phenomenon occurred in the engine fuel system.

4. SAFETY RECOMMENDATIONS

Following this accident, the investigation commission doesn’t issue any civil aviation safety recommendation.

Note: The documents and analysis objects used for the issuance of the flight safety investigation Report are confidential and are archived at the Civil Aviation Safety Investigation and Analysis Authority (SIAA), according to the legal provisions.