Federal Public Service
Mobility and Transport
Air Accident Investigation Unit

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(Belgium)
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Safety Investigation Report

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Status: Final

SYNOPSIS

Classification:	Accident
Level of investigation:	Standard
Date and time:	18 April 2014 at 13:50 UTC
Aeroplane:	Manufacturer: Halley Kft. Model: Apollo Fox 912 The aircraft was registered in Belgium since 14 July 2010 and held a valid 'Permit to fly'.
Owner:	The pilot
Total flight time:	About 600 FH
Engine:	One Rotax 912 UL SN: RO-270227
Accident location:	In a field located in Mochamps near the airfield of St Hubert (EBSH) - 50°06'06.0"N 5°24'49.4"E
Type of flight:	General aviation - Cross-country
Phase:	Climbing after the take-off
Persons on board:	The pilot was alone on board.
Injuries:	None

Abstract
A few minutes after take-off from the St Hubert airfield, the pilot noticed that the engine oil pressure had dropped to zero. Shortly after, the engine stopped operating. Attempts to activate the emergency parachute failed leaving the pilot with no choice but to perform a forced landing.

Cause
The cause of the accident is an engine failure resulting from a complete loss of engine oil pressure due to a failure of an oil cooler hose connection. The hose failure occurred as a consequence of the modification of the engine lubrication system causing the oil cooler and associated oil hoses to be submitted to oil pressure instead of oil suction.

Because the emergency parachute system could not be activated, a forced landing on a very uneven terrain had to be executed, causing the aeroplane to flip over.

Contributing factors:

- Unawareness of the hazards associated with the application of a non-validated modification,
- Inadequate position of the emergency parachute handle.
- Generally speaking, the absence of review of the different modifications by a competent/experienced third party, independent from the person who performed the modification.
- There is no formal technical standard such as Certification Specification for initial design and/or modification of ultralight aircraft.
- Regular generation of false alarms during take-offs.

Safety actions and recommendations:

Recommendation BE-2016-0005:

It is recommended that the BCAA revises the Belgian regulation on ultralight aeroplanes in order to provide a clear framework covering the possible modifications.

Recommendation BE-2016-0006:

It is recommended that the BULMF provides some guidance, limitations and cautions in order to mitigate the risks associated with the performance of non-validated ultralight aeroplane modifications.

Safety message[1] to the ultralight owners

Accident investigation reports (including this one) show that non-validated modifications applied to an aircraft, and the engine in particular, have the potential to cause malfunctions and possibly an accident.

To avoid mishaps, extreme care must be exerted when modifying an existing design on aircraft. The following rules should be considered:

- First of all weighing out the (possible) performance benefits against the hazards and risks. Is the modification really needed?
- Looking beyond the obvious.
- Have the design verified by experienced persons, independent from those having developed it.
- Determine the possible failure modes of the system being designed, and define compensating actions.
- Make sure that all material used in the design is compatible with the specifications of the new design.
- Have the installation verified independently by experienced persons, not directly involved in the modification itself.

[1] **Safety message:** An awareness which brings under attention the existence of a safety factor and the lessons learned. AAIU(Be) can disseminate a safety message to a community (of pilots, instructors, examiners, ATC officers), an organization or an industry sector for it to consider a safety factor and take action where it believes it appropriate. There is no requirement for a formal response to a safety message, although AAIU(Be) will publish any response it receives.

FACTUAL INFORMATION

History of the flight

The aeroplane first performed an uneventful navigation flight from its home base, Airfield of Hannut/Avernas (EBAV) to the airfield of St Hubert (EBSH).

After a rest period, the pilot decided to fly back to his home base. The take-off was uneventful except that the red and white alarm lights of the engine monitoring system (MGL Infinity E3) flashed during the climb-out. As stated by the pilot, the alarm lights activated regularly during take-offs due to the engine overspeed detection system being set at a too low value. As usually, the pilot did not worry about it and deactivated the alarm without actually checking the other engine parameters.

A few minutes after the take-off when flying at 3500 ft QNH (about 2000 ft AGL at that location), the pilot felt a strange smell and he saw that the engine oil pressure had dropped to zero. He decided to proceed to EBSH but he rapidly realized he could not reach the airfield. Shortly after, the engine stopped operating. The pilot, in radio and radar contact with the military Flight Information Service (Belga Radar), declared “Mayday” and announced he was about to activate the emergency parachute.

Taking into account that no adequate field was available to perform a forced landing, he switched the ignition off, closed the fuel shut off valve and tried twice to activate the emergency parachute handle, without result.

He had no other choice but to make a forced landing on a very uneven terrain causing the nose landing gear to collapse and the aeroplane to flip over. The aeroplane was significantly damaged but did not catch fire. The pilot, properly fastened by his shoulder harness seat belt, exited the aeroplane uninjured.

Airfield information

The EBSH Saint-Hubert airfield is an airfield located at 2,5 km NE of the city of Saint-Hubert. Coordinates: 50°02'09"N - 005°24'15"E. Elevation: 563m (1847 ft). It is equipped with four grass runways: 05L/23R and 05R/23L: 600 m long x 42 m wide. 14L/32R and 14R/32L: 799 m long x 42 m wide.

Pilot information

Age: 45 years old. Ultralight Pilot Licence, first issued 10 February 2011, valid until 02 January 2016. Experience: About 100 FH experience as ultralight pilot from which 80 FH on the accident aeroplane. The pilot was one of two co-owners.

The pilot had a previous experience as a glider pilot (about 100 FH over a period of 10 years), which he claimed helped him a lot during the incident; Glider pilots are used to flying aircraft without engines, and are trained to continuously scan the terrain for a possible off-field landing.

Meteorological information

METAR EBSH: Temperature: 08°C, dew point: 02°, Wind: 350° (320V030) 9 knots, Visibility +10 km and QNH: 1014 hPa.

Aeroplane information

The Apollo Fox is an ultralight aeroplane produced by the Hungarian company Halley. It features a strut-braced high-wing and a two-seats-in-side-by-side configuration enclosed cockpit. The aircraft fuselage is made from welded steel tubing, while the wing is built with aluminium spars and ribs. The fuselage and flying surfaces are covered in doped aircraft fabric.

The accident aeroplane was equipped with a 80 hp (60 kW) Rotax 912UL four-stroke powerplant and a fixed tricycle landing gear.

The aircraft configuration showed three deviations from the original design, as accepted by the Belgian Civil Aviation Authority (BCAA) upon registration in Belgium:

- The installation of an emergency parachute, that the owner stated was applied by the aircraft manufacturer some time ago (Make and type: Galaxy GRS “Ballistic parachute rescue system”, manufactured in Czech Republic).
- The installation of an oil temperature regulating system
- The installation of a water temperature regulating system.

The two last modifications were recently installed by the owners themselves based on non-validated information found on the Internet. BCAA had no knowledge of any application request regarding these modifications.

Damage

Figure 1: Aircraft just after the accident

The engine cowling was covered with engine oil. The engine suffered a significant oil leak and subsequent mechanical damage caused by the engine running without oil.

In addition to the damage to the engine, most primary airframe structures were bent or distorted by the flip over during the forced landing.

Regulation on ultralight aeroplane modification

Article 28 of Royal Decree ’Ultralight aeroplanes’ dated 25 May 1999 states that the ’Permit to Fly’ can be withdrawn by the civil aviation authority, amongst others, in case of structural modification of the aircraft or a part of the aircraft.

Art. 28. L'autorisation restreinte de circulation aérienne peut être retirée par le Ministre chargé de l'administration de l'aéronautique ou par le Directeur général de l'administration de l'aéronautique:

- **1° en cas de modification structurelle apportée à l'aéronef ou à un élément de l'aéronef;**
- **2° en cas d'avarie;**
- **3° en cas de défaut d'entretien;**
- **4° si l'aéronef ultra-léger motorisé comporte un vice présentant un danger pour la sécurité aérienne.**

Le Ministre chargé de l'administration de l'aéronautique ou le Directeur général de l'administration de l'aéronautique retire l'autorisation de type d'un aéronef ultra-léger motorisé qui présente un vice affectant la sécurité de vol de ce type d'aéronef.

Art. 28. De beperkte toelating tot het luchtverkeer kan ingetrokken worden door de Minister die met het bestuur van de luchtvaart is belast of door de Directeur-generaal van het bestuur van de luchtvaart:

- **1° in geval een wijziging aan de structuur van het luchtvaartuig of van een onderdeel van het luchtvaartuig is aangebracht;**
- **2° in geval van averij;**
- **3° in geval van gebrek aan onderhoud;**
- **4° indien het ultralicht motorluchtvaartuig een gebrek vertoont waardoor de luchtvaartveiligheid in gevaar wordt gebracht.**

De Minister die met het bestuur van de luchtvaart is belast, of zijn Directeur-generaal van het bestuur van de luchtvaart trekt de type- toelating in voor het ultralicht motorluchtvaartuig dat een gebrek vertoont waardoor de vliegveiligheid van dat type van luchtvaartuig wordt aangetast.

Figure 2: Extract of Royal Decree ’Ultralight aeroplanes’ dated 25 May 1999

This Royal Decree ’Ultralight aeroplanes’ is accompanied by ’Circular Airworthiness n°12’ in which Chapter 1.3 pertains to the possible modifications.

The circular is more detailed than the Royal Decree. It states that an alteration file, established following the same rules as the original technical file, shall be compiled for any major alteration of an ultralight aeroplane.

A summary definition of what could be seen as a major modification is included in this chapter.

1.3 Modification

Toute modification majeure d'un aéronef ultra-léger motorisé ayant reçu antérieurement une autorisation de type doit faire l'objet d'un dossier de modification établi suivant les mêmes règles que pour l'établissement du dossier technique de base.
On entend par "modification majeure" toute modification qui a un effet appréciable sur les performances, la masse, le centrage, la résistance structurale, la fiabilité, les caractéristiques d'utilisation ou toute autre caractéristique qui affecterait la navigabilité de l'aéronef ultra-léger motorisé.

1.3 Wijziging

Elke belangrijke wijziging aan een ultralicht motorluchtvaartuig waarvoor eerder een typetoelating werd afgeleverd, dient verantwoord te worden in een wijzigingsdossier, opgesteld volgens dezelfde regels als voor het technisch basisdossier.
Onder “belangrijke wijziging” verstaat men elke wijziging die een aanzienlijk effect heeft op de prestaties, de massa, de zwaartepuntsgrenzen, de structurele weerstand, de betrouwbaarheid, de gebruikerskarakteristieken of iedere andere karakteristiek waardoor de luchtwaardigheid van het ultralicht motorluchtvaartuig wordt aangetast.

Figure 3: Extract of ’Circular Airworthiness n°12’

A ’major modification’ is defined as a modification having a noticeable effect on aircraft performances, the mass, the balance, the structural strength, the reliability, the operational characteristics, or any other characteristics affecting the airworthiness of the ultralight motorized aircraft.

ANALYSIS

The cause of the engine failure was identified soon after the accident as being a sudden total loss of lubrication due to a flexible pipe disconnection at one oil cooler connector.

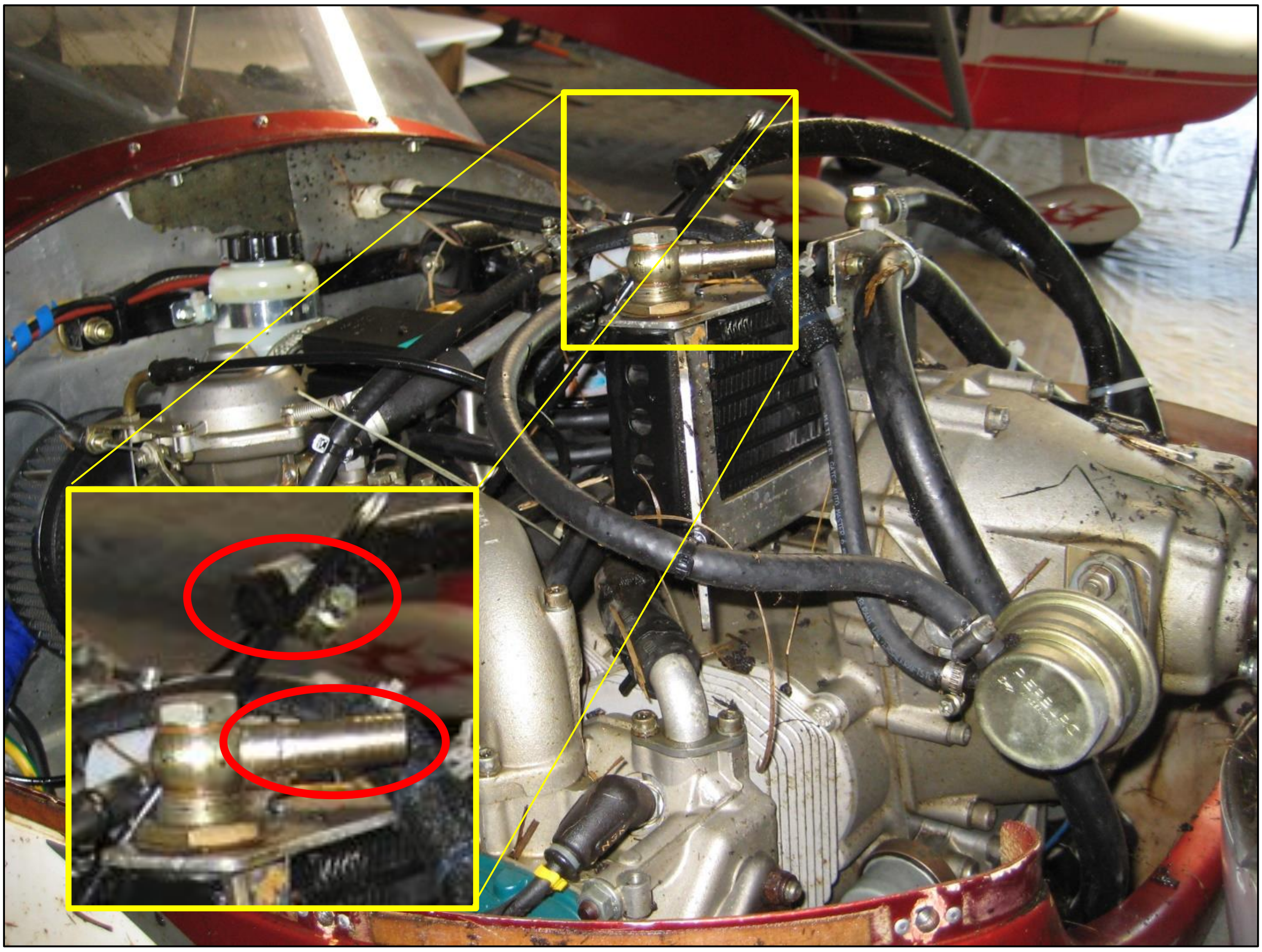

Figure 4: Picture of the engine showing the oil pipe disconnected

Interview of the pilot showed that the lubrication system had been recently modified in order to install a system aiming to reduce the time to reach the nominal oil temperature and to maintain this temperature at a constant value.

At the same time, the cooling system was also modified for the same reason. These modifications had been performed about 5 flight hours (3 or 4 flights) before the accident.

Description of the original engine manufacturer lubrication system

The oil pump is driven by the camshaft. The oil pump sucks the engine oil (green arrow) from the oil tank via the oil cooler and forces it through the oil filter to the individual point of lubrication. The surplus oil emerging from the points of lubrication accumulates on the bottom of the crankcase and is forced back to the oil tank by the crankcase blow-by gases (blue arrow).

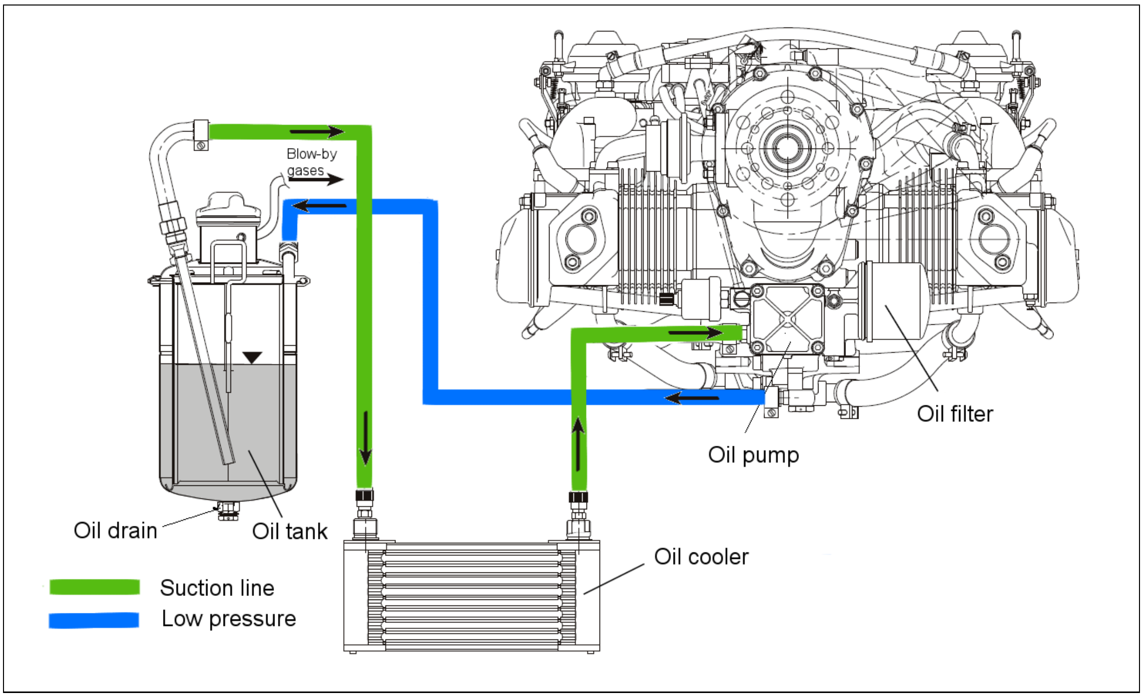

Figure 5: Diagram of the original engine manufacturer lubrication system

Description of the lubrication system after modification

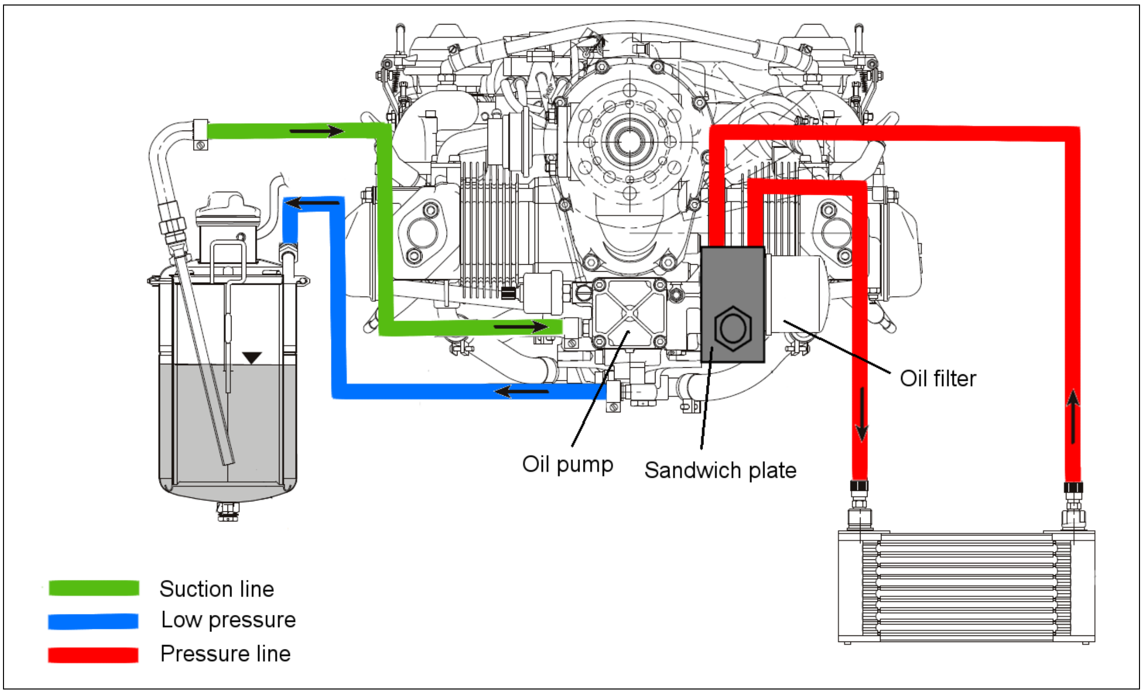

Figure 6: Diagram of the lubrication system after modification

The modification consisted in the installation of a thermostatic valve and the rerouting of the external oil circuit. A sandwich plate incorporating the thermostatic valve was installed between the oil filter and the engine oil pump. The modification resulted in the oil cooler and oil cooler lines being under the engine oil pressure while it was previously submitted to oil suction.

Unlike the external oil circuit, the engine internal lubrication system was not altered by the modification.

Description of the failed oil cooler connection

Figure 7: Picture of the failed oil cooler connection

The steel tube of the connector is made of 2 different outer diameter steel tubes welded together (Ø 12mm and 13mm).

When asked about the rationale of this particular design, the aeroplane manufacturer answered that it had not been a problem so far. But no actual justification was given.

The end of the tube is barbed by machining 4 small grooves meaning that the external Ø of the barbed portion of the tube shows the same Ø as the tube (12 mm).

The force necessary to put the rubber pipe into place again on the connector was next to nothing, particularly when sliding the flexible rubber pipe on the 12 mm Ø portion.

Further disassembly of both parts (not equipped with a clamping ring) showed that the barbed end could not prevent the hose slipping off the connector tube. It demonstrates that the coupling of the flexible pipes with this type of connector was not designed to withstand oil pressure.

Figure 8: Picture of the rubber pipes as fitted on the connectors on sandwich plate.

Figure 9: Picture of a connector before installation of the rubber pipe

The connectors screwed in the sandwich plate are quite different, compared with those installed on the oil cooler. The barbed end has a larger Ø than the tube itself. The assembly of the rubber pipe on the connector requires the pipe to be heated and lubricated in order to allow sliding the pipe onto the connector. When installed, the flexible pipe becomes almost irremovable due to the shape and larger Ø of the barbed end and the tight fit of the rubber pipe on the connector, even when no clamp is installed.

During the oil circuit modification, both original oil cooler connectors and lines were retained. The flexible rubber pipes were not disassembled from the oil cooler connectors, by contrast the other ends of the hoses (side of the sandwich plate) were fitted with new connectors.
It is important to underline that the reused hoses[2] were not pressure tested while good practice should ensure that they are suitable for their new working pressure. They should have been pressure tested at the new working pressure increased by a given multiplying factor.

The pilot stated that he was convinced he took all necessary information into account to verify that the design and the components needed for the modification were safe. Amongst others, he checked the pressure characteristics of the oil cooler, the rubber lines characteristics etc. The owner also stated that he never imagined that the design of the original oil cooler connectors was conducive to disconnection when submitted to oil pressure.

Ergonomics of the emergency parachute system

The pilot twice tried to activate the Galaxy GRS emergency parachute system by moving forward the parachute handle with all his strength – but without success. He stated that the handle movement required a significant forward force that he was not able to apply due to the uncomfortable position of the handle. This handle was fixed to, and installed above a structural diagonal tube of the fuselage structure located in the roof of the cabin, approximately above the pilot's left shoulder.
Because of the handle location, the pilot had to raise his arm vertically before reaching the handle with the tip of 2 fingers. When doing that, the structural tube was located in the recess between the fingers.

Figure 10: Location of activation handle

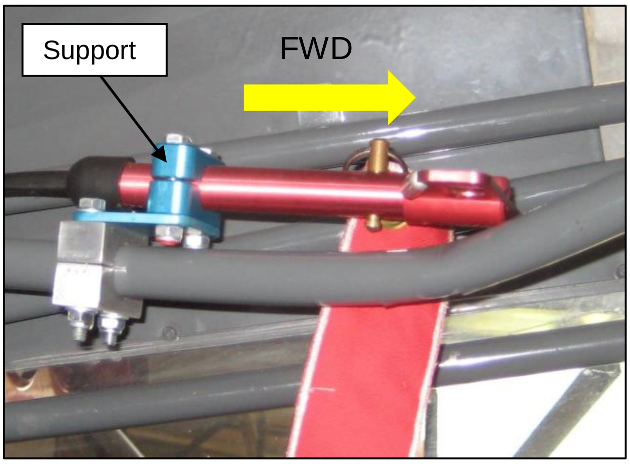

Figure 11: Installation of activation handle

The force required to move the activation handle is 11 kg and the distance for stretching the trigger mechanism is about 7 cm. For information, it takes more force, i.e. 35-40 pounds (17-19 kg) of pulling on the activation handle to fire a rocket of the BRS Aviation type.

The Galaxy GRS *Instruction manual for assembly and use* provides installation instructions to ensure the system to work successfully in case of emergency.

[2] Hose definition: the assembly of a flexible pipe together with connector ends.

6.4 Placement of activation handle.

Mount the activation handle so that it is visible and accessible to both members of the crew. Consider that the possible distance to the launching handle is limited by tighten seat belts. It is forbidden to make loops with the bowden – the GRS system can not be activated when the bowden is looped! The smallest bend radius should be no less than 5 cm, lead the bowden as streight as possible.

The activation handle must not be close to other controls. There must be sufficient clearance around the handle to allow easy grasping with a gloved hand. It should be placed so as to be clearly visible to the eyes of the crew, no extreme head rotation needed.For the safe activation the pull of 5-7 cmof the activation handle is enough, but we recommend a free space of ca. 30 cm for the free move of elbow. The cable in the bowden is pre-sprung in a loop which must be drawn out completely to activate the system. The bowden must be routed and mounted such as to avoid sharp bends that might increase required pulling strain or even prohibit the system from firing. Cables must be neatly fixed to avoid tangling with moving parts or crew. Nuts must be secured against loosening. The bracket of the activation handle must be firmly mounted using both screw holes. If the bracket was to come adrift on pulling the handle, the system will not be activated.

Figure 12: Extract of the "Galaxy GRS" manual

Therefore, it is very important, during the installation of an emergency parachute system, to carefully consider the best possible position for the activation handle.
The "Galaxy GRS" installation instructions regarding the position of the activation handle are deemed adequate. Obviously, these instructions were not sufficiently taken into account by the installer.

In summary, the combination of some ergonomic problems was identified to be the cause of the pilot's inability to activate the emergency parachute system:

- The general position of the handle requiring the pilot to lift his arm vertically above the shoulder – you have less strength to push on something when your arm is in a vertical position than in an horizontal position between hips and shoulder.
- The direction of the force to be exerted – to have the least friction, the cable should be moved in the same direction as its housing (horizontal and forward in this case). However in this position, it is not easy for the pilot to see (and assess) the right direction, leaving the possibility that he pulls in a too far downward direction, generating extra friction in its support and housing.
- The position of the handle above the diagonal tube causing this tube to be an obstacle for a full hand grip.

Pilot's actions

The flashing alarm of the engine monitoring system was deactivated by the pilot during the climb-out, assuming that this was only caused by a small overspeed of the engine. The pilot deactivated the alarm system before the first obvious signs of engine oil leak (Burning oil smell) without thinking that the tripping of the alarm system was possibly due to an actual anomaly.

The investigation could not determine the actual reason for the alarm tripping, overspeed and/or low oil pressure. Nevertheless, the possibility exists that the alarm system tripped to warn the pilot about a low oil pressure situation. Earlier detection of this engine problem would have given the pilot more chance to return to EBSH before the engine failure.
Under the circumstances of the accident, the pilot performed different reasonable actions:

- From the moment the oil pressure was dropping, he decided to return to EBSH.

- He made a Mayday call.
- When realizing it was impossible to reach the airfield he evaluated the chance of performing a safe forced landing.
- Considering that a forced landing was not the safest option, he took the decision to activate the emergency parachute.
- Because of the impossibility of actuating the emergency parachute handle he selected a field that for him seemed the least bad field available to land.
- He maintained the control of the aeroplane to the ground.

In spite of the time wasted trying to activate the emergency parachute and the additional stress and distraction induced by this attempt, the pilot succeeded in flying the aeroplane to avoid a possible loss of control.

The pilot stated that based on his experience as sailplane pilot he was always mentally ready to perform an unscheduled landing. This helped him to rapidly select a field for the forced landing.

About the regulation regarding the modification of ultralight aeroplanes

There is a discrepancy between the prescriptions found in the Royal Decree and those found in the Circular.

The Royal Decree prescribes only that the 'Permit to fly' can be withdrawn in case of <u>structural modification</u> of the aeroplane while the circular cast on a wider range of modifications, covering amongst others those modifications possibly affecting the technical reliability of the aeroplane.

The circular requests the elaboration of a technical file regarding the modification. However it is not clear that this technical file and/or the modification itself must be submitted to the BCAA. The rationale underlying the requirement for the technical file is not further explained.

There is no formal technical standard such as Certification Specification for initial design and/or modification of ultralight aircraft.

For example, CS-23 "Certification Specifications and acceptable Means of Compliance for Normal, Utility, Aerobatics, and Commuter Category Aeroplanes" applicable to certified aeroplane states the following:

> **CS 23.1017 Oil lines and fittings**
>
> (a) *Oil lines.* Oil lines must meet CS 23.993 and must accommodate a flow of oil at a rate and pressure adequate for proper engine functioning under any normal operating conditions.

> **CS 23.993 Fuel system lines and fittings**
>
> ....
>
> (d) Each flexible hose must be shown to be suitable for the particular application.
>
> ....

CONCLUSIONS

Findings

- The aeroplane held a ‘Certificate of registration’ and a valid ‘Permit to fly’
- Three modifications have been applied since the issuing of the ‘Permit to fly’ by the BCAA. None of these modifications had been submitted to the BCAA.
- The pilot was duly qualified and licensed for piloting ultralight aeroplanes. He was also a sailplane pilot.
- A discrepancy exists between the requirement of the Royal Decree and the Circular regarding the modification of ultralight aeroplanes. As it is described in the circular, the obligation to complete a modification file and possibly provide a copy of it to the BCAA is not clear.
- An oil cooler hose failed in flight when its flexible pipe had pulled out of the connector.
- The original design of the oil cooler hoses wasn’t a problem when, in the original installation, the hoses were submitted to suction. After the oil system modification, the hoses were submitted to oil pressure. The particular and inexplicable design of the connectors made it impossible for the assembly flexible pipe/connector to withstand the pull-out force resulting from the oil pressure.
- The activation of the emergency parachute handle, located in the ceiling behind a structural tube was very uncomfortable and not functional for the pilot. This caused the pilot to fail activating the emergency parachute system.
- In spite of the different failures (engine, parachute system, etc.), the pilot kept flying the aeroplane throughout.
- The pilot had no other choice than to perform a forced landing on a very uneven terrain causing the nose landing gear to collapse and the aeroplane to flip over.

Cause

The cause of the accident is an engine failure resulting from a complete loss of engine oil pressure due to a failure of an oil cooler hose connection. The hose failure occurred as a consequence of the modification of the engine lubrication system causing the oil cooler and associated oil hoses to be submitted to oil pressure instead of oil suction.

Because the emergency parachute system could not be activated, a forced landing on a very uneven terrain had to be executed, causing the aeroplane to flip over.

Contributing safety factors

- Unawareness of the hazards associated with the application of a non-validated modification.
- Inadequate position of the emergency parachute handle.
- Generally speaking, the absence of review of the different modifications by a competent/experienced third party, independent from the person who performed the modification.
- There is no formal technical standard such as Certification Specification for initial design and/or modification of ultralight aircraft.
- Regular generation of false alarms during take-offs.

Other safety factors

- Lack of clarity of the regulation [safety issue]
- Lack of formal technical standards [safety issue]

SAFETY ACTIONS AND RECOMMENDATIONS

Lack of clarity of the regulation
The BCAA regulation is not clear regarding the possible modifications of ultralight aeroplanes and differences exist between the Royal decree and the Circular covering the same subject.

Recommendation BE-2016-0005:

It is recommended that the BCAA revises the Belgian regulation on ultralight aeroplanes in order to provide a clear framework covering the possible modifications.

Lack of formal technical standard
There is a lack of formal technical standards such as Certification Specification for initial design and/or modification of ultralight aircraft, as it is available for certified aircraft.
The Belgian ULM federation could provide some worthwhile guidance, limitations and cautions in order to mitigate the risks associated with the performance of non-validated modifications and also advise ultralight aeroplane owners who still intend to modify their aeroplane to use the CS 23, CS VLA or CS Engine specifications as a source of inspiration for the design of modifications. Therefore:

Recommendation BE-2016-0006:

It is recommended that the BULMF provides some guidance, limitations and cautions in order to mitigate the risks associated to the performance of non-validated ultralight aeroplane modifications.

Safety message to the ultralight owners

At least two of the three applied modifications (the water cooling system was not examined) exhibited design problems not detected by the pilot/owner. However, the inadequate position of the emergency parachute handle should have been evident to anybody examining critically the installation of the parachute system.

Also, the inadequate design of the oil hose connectors was easily detectable when examined by an experienced mechanic. Moreover, the weak connection of the rubber line/connector should have been detected during a pressure test of the hoses.

Although the owner was convinced he had taken all necessary precautions, none of these design problems were detected.

Therefore the following safety message addressed to owners who plan to modify their ultralight airplanes:

Accident investigation reports (including this one) show that non-validated modifications applied to an aircraft, and the engine in particular, have the potential to cause malfunctions and possibly an accident.

To avoid mishaps, extreme care must be exerted when modifying an existing design on aircraft. The following rules should be considered:

- **First of all weighing out the (possible) performance benefits against the hazards and risks. Is the modification really needed?**
- **Looking beyond the obvious.**
- **Have the design verified by knowledgeable persons, independent from those having developed it.**
- **Determine the possible failure modes of the system being designed, and define compensating actions.**
- **Make sure that all material used in the design are compatible with the specifications of the new design.**
- **Have the installation verified independently by knowledgeable persons, not directly involved in the modification itself.**

About this report

As per Annex 13 and EU regulation EU 996/2010, each safety investigation shall be concluded with a report in a form appropriate to the type and seriousness of the accident and serious incident. For this occurrence, a limited-scope, fact-gathering investigation and analysis was conducted in order to produce a short summary report.
It is not the purpose of the Air Accident Investigation Unit to apportion blame or liability. The sole objective of the investigation and the reports produced is the determination of the causes, and, where appropriate define recommendations in order to prevent future accidents and incidents.