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COMISIÓN DE
INVESTIGACIÓN
DE ACCIDENTES
E INCIDENTES DE
AVIACIÓN CIVIL

Report
ULM A–005/2015

Accident involving an Air Creation Kiss 450 GTE 582S aircraft, registration EC-LGM, at the Casarrubios del Monte aerodrome (LEMT-Toledo, Spain) on 24 April 2015

GOBIERNO DE ESPAÑA
MINISTERIO DE FOMENTO

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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.

Contents

Abbreviations

AESA	Spain's National Aviation Safety Agency
BEA	Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile- French Safety Investigation Authority
DGAC	Spain's Civil Aviation General Directorate
EW	Empty Weight
FI	Flight Instructor
Ft	Feet
h	Hours
IPC	Illustrated Parts Catalogue
kg	Kilograms
km	Kilometers
Km/h	Kilometers/hour
kw	Kilowatts
l	Liters
LEMT	Casarrubios del Monte aerodrome (Toledo, Spain)
m	Meters
MTOW	Maximum Take Off Weight
N	North
N/A	Not affected
OM	Operations Manual
RPM	Revolutions per minute
RTC	Radio Operator
SB	Service Bulletin
S/N	Serial Number
TULM	ULM license
ULM	Powered ultralight
UTC	Universal Time Coordinated
W	West
WSC	Weight shift control

Synopsis

Owner and Operator:	Eolo Marketing
Aircraft:	Air Creation Kiss 450 GTE 582S, registration EC-LGM
Date and time of accident:	Friday, 24 April 2015 at 09:00 local time[1]
Site of accident:	Casarrubios del Monte aerodrome (Toledo, Spain)
Persons onboard:	2, instructor and student, seriously injured.
Type of flight:	General aviation - Flight training - Dual controls
Date of aproval:	22 February 2017

Summary of the accident:

The aircraft, a tandem trike, was on a local dual-control training flight, with the student seated at the front and the instructor at the back. While doing a touch and go on runway 26, after they were airborne, eyewitnesses reported hearing a change in the engine RPMs. The aircraft started to turn left and head for an area of the aerodrome where the fuel tanks are located and where scrap metal was piled up. The main gear wheels on the aircraft impacted a pile of metal sheets and the nosewheel gear impacted the ground. The occupants were seriously injured and the aircraft sustained considerable damage.

It was concluded that the accident occurred when a part of the engine exhaust system detached during the takeoff maneuver, impacting a propeller. The investigation determined that the exhaust system outfitted by the aircraft manufacturer (Air Création) did not conform to the requirements of the engine manufacturer (ROTAX). Contributing to the accident is the fact that the owner/operator had not carried out the maintenance tasks specified in the Maintenance Manual, and which would have revealed the potential problems with the escape system components.

The Safety Investigation Authority from France (BEA) requested that a copy of their comments be included in the report as an Appendix (see Appendix E).

[1] All times in this report are local unless otherwise specified. To obtain UTC, subtract 2 hours from local time.

1. FACTUAL INFORMATION

1.1. History of the flight

According to their statement, the occupants had been flying for about one hour practicing different maneuvers, since the following week (on Thursday, 30 April 2015) the student was scheduled to be tested. After these maneuvers, they did a touch and go on runway 26, and as they were climbing, they heard a noise and something they did not identify at first detached and struck the propeller blades. The student yielded control to the instructor (saying "yours") and the instructor attempted to fly straight to the end of the runway, where there were a few shrubs that he hoped would cushion the impact. Since they were just gaining height, he did not have enough speed to control the aircraft and the sail (the aircraft's wing) was not tensioned. Instead of continuing straight, and despite the instructor's efforts to steer the aircraft, it started turning left without gaining any altitude, until the main gear impacted some stacked metal sheets in an area where scrap metal was piled up. The aircraft then impacted the ground, seriously injuring the occupants. The aircraft was heavily damaged (see Photograph 1).

Photograph 1. Aircraft after the accident

According to the two occupants, they had checked the exhaust system before the flight, as required by the manual, by using the pre-flight checklist. The previous afternoon they had noticed that one of the clamps holding two exhaust parts together (the muffler and after-muffler) was missing, and that there was a small crack on the weld of the butterfly-shaped part that supported both components

(see Figure 7). A new clamp was installed (consisting of two shorter clamps joined together), which they assumed would suffice, without further considerations.

During the onsite investigation, the recently replaced clamp and the after-muffler were found on the ground between the runway in use and the taxiway. Aerodrome personnel picked up part of the exhaust system[2] on the taxiway. All of the components were found along the route presumably taken by the aircraft (see Appendix A).

1.2. Injuries to persons

The aircraft's occupants were seriously injured. Both were conscious after the accident and were taken to a hospital.

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

1.3. Damage to aircraft

The aircraft sustained heavy damage (see Section 1.12., Wreckage and impact information).

1.4. Other damage

There was no additional damage beyond that sustained by the aircraft.

1.5. Personnel information

The instructor, a 43-year old Spanish national, had a valid and in force TULM license since 2011 and WSC (weight-shift control) and RTC (radio operator) ratings, and an FI (flight instructor) rating valid until 22 December 2015. He had a class-2 medical certificate that was valid and in force until 3 September 2015. According to his

[2] Elbow between the muffler and after-muffler.

flight log, he had a total of 484:32 flight hours, 460:37 of them on the accident aircraft.

The instructor was also the aircraft's co-owner and Head of Operations and member of the Eolo Marketing school. This school was not very active and only had the accident aircraft for its training activities.

The student pilot was a 41-year old Spanish national. He had a student permit that was valid and in force until 1 July 2015, and a class-2 medical certificate that was valid and in force until 2 September 2015. He had been flying since July 2013. He had 27:30 hours of flight time, according to the school's records, and had 8:17 solo hours. He had flown 45 minutes the previous day, but according to the instructor's notes, the last flight prior to that one had been in October 2014 (last flight logged on 17/10/2014). The student had not flown since October because there was no WSC examiner at AESA. An exam was requested for November 2014, and after three months went by without a reply, the school filed a claim, as per procedure. An examiner was eventually assigned for 30 April 2015.

1.6. Aircraft information

1.6.1 General information

The ultralight aircraft, an Air Creation Kiss 450 GTE 582S trike, registration EC-LGM and serial number 09054-AR, was manufactured in 2010. According to the information in the AESA registry, its maximum takeoff weight (MTOW) was 450 kg and its empty weight (EW) was 188 kg.

The aircraft had a Type Certificate of Airworthiness, no. 195-I/2, issued by the DGAC and held over by AESA[3]. According to the datasheet for this certificate, the model had been approved on 29 July 2003. It had a KISS450 wing and a GTE tricycle. Power was provided by a ROTAX 582S[4] two-stroke, two-cylinder engine with two carburetors and dual ignition. The exhaust system was specific to the engine model. The propeller was a four-bladed Arplast with a 1.66-m diameter and a pitch that was adjustable on the ground. The blades were made from fiberglass with a carbon fiber core embedded in epoxy resin.

According to this information, the MTOW was 446 kg and the fuel capacity was 60 l. The demonstrated performance indicated a maximum speed for the aircraft of 108 km/h and a stall speed of 62 km/h.

[3] As per the requirements in the OM from 14 November 1998.

[4] According to the authorized center, the exact model was a Rotax 582ULS model 99.

The aircraft had a Registration Certificate, a Restricted Certificate of Airworthiness in the School category, an Aircraft Station License and an Insurance Certificate, all of them valid and in force. The aircraft had originally been based at the Brunete (Madrid) airfield, though it had changed its base to the Casarrubios del Monte aerodrome in March 2014. The aircraft had been purchased new and had 768 hours (on 28 March 2015).

The aircraft's last flight had been a one-hour local flight that, according to the entry in the instructor's flight log, had taken place on 5 April 2015.

The aircraft had flown 5:20 hours in January, 4 hours in February and 6 hours in March.

Photograph 2. Photograph of the aircraft

1.6.2 Maintenance information

The instructor kept a sheet with the maintenance activities that were carried out on the aircraft. The maintenance entries started on 6 July 2013 and ended on 28 March 2015. There is no maintenance information prior to the first date. In general, the requirement was to clean the spark plugs every 10 hours and to replace them every 30. The aircraft was overhauled twice, once on 6 July 2013 (with 550 hours on the engine) and again on 17 July 2014 (with 693 hours on the engine).

The Maintenance Manual supplied by the distributor to the owner included a table with the required maintenance schedule (see Appendix B). This table specified,

among other things, that the overhaul should be conducted at an authorized service center.

Neither of the overhaul entries indicated the maintenance tasks carried out during said overhaul. The overhaul was not performed at an authorized center. The tasks logged did not make any reference to the exhaust system. It was not possible to obtain any statement from the people who performed that overhaul.

1.7. Meteorological information

The available weather information closest to the accident site is from the station in Toledo, about 30 km away from the Casarrubios aerodrome. This information, along with satellite and radar images and adverse phenomena warnings, indicate that the most likely weather at the crash site was as follows: very light wind (4 km/h) from the south, overcast though with good visibility on the surface, a temperature of 15º C and a relative humidity of 65%. There was no significant precipitation or adverse weather warnings.

1.8. Aids to navigation

Aids to navigation were not used.

1.9. Communications

There were no communications between the occupants and the aerodrome.

1.10. Aerodrome information

The Casarrubios aerodrome is a private airfield located in the province of Toledo at coordinates N 40º 14' 06", W 04º 01' 53". It is at an elevation of 2050 ft and it has one asphalt runway, 986 m long and 26 m wide, in an 08/26 orientation. The aircraft took off from runway 26 on the day of the accident (see Photograph 3).

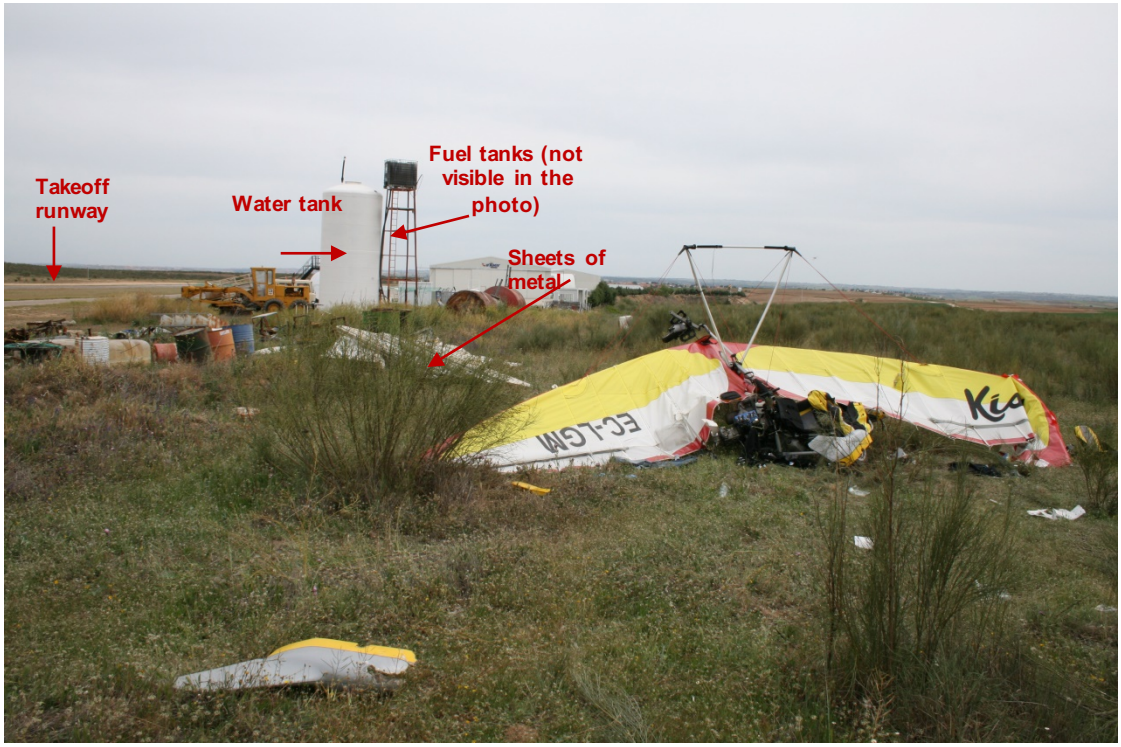
Photograph 3. Aerial view of the Casarrubios aerodrome (LEMT)

1.11. Flight recorders

The aircraft was not equipped with flight recorders, nor were they required for this aircraft type.

1.12. Wreckage and impact information

The accident aircraft was some 80 meters left of the runway 26 centerline (see Appendix A). During its takeoff run and a few meters off the ground the aircraft turned left and its landing gear impacted some stacked metal sheets, scattering them over the ground and causing the aircraft to flip (see Photograph 4).



Photograph 4. Condition of the aircraft after the accident

On the runway, one of the propeller blades and debris from the other blades were found starting at the displaced threshold markings (see Appendix A). Beyond this debris, at the edge of the runway and along the aircraft's likely trajectory, was one of the exhaust fastening clamps (consisting of two smaller clamps fitted together). The after-muffler was found between the runway and taxiway, with abrasion marks (see Appendix A and Photograph 5).

Photograph 5. Exhaust components found along the aircraft's path

The right part of the sail (wing) had a gash that was probably caused by impacts from the debris that detached from the propeller blades.

Aerodrome personnel turned in the elbow joining the muffler and the after-muffler, which was found in the taxi area adjacent to where the rest of the exhaust parts were found (see Appendix A and Photograph 6).

Photograph 6. Elbow from the exhaust system found by aerodrome personnel

The parts of the exhaust system that were broken were: the fastening clamp installed the day before (consisting of two clamps joined together), one of the wings from the butterfly-shaped fastening and support piece and the elbow where it welds to the muffler.

1.13. Medical and pathological information

Both occupants were admitted to a hospital with various fractures and injuries. They were subsequently operated on.

1.14. Fire

There was no fire.

1.15. Survival aspects

The occupants were treated within minutes of the accident by aerodrome personnel. They were both wearing their safety harnesses (which worked correctly and showed abrasion marks), from which they were cut out.

1.16. Tests and research

See Section 1.18.3, "Engine inspection"

1.17. Organizational and management information

The Eolo Marketing S.L. school was authorized by AESA as a ULM Flight School, extended until 26 April 2015. The school had purchased the aircraft on 3 December 2009 and had been operating out of the Casarrubios aerodrome since 1 March 2014.

On 16 April 2015, AESA inspected the school as part of its oversight of the ULM Flight School. This inspection resulted in the following discrepancies:

- There were no signed time sheets.
- There was no daily flight logbook.
- The second instructor's license was expired[5].
- There was no aircraft maintenance program.
- There was no indication that an aircraft maintenance record book exists.

The school was given 10 days to respond to these findings.

1.18. Additional information

1.18.1 Statements

1.18.1.1 Statement from the instructor

The information on the accident provided by the instructor is contained in Section 1.1., "History of the flight". As for the aircraft's maintenance, the instructor (who was also the co-owner of the aircraft and a partner in the School) stated that they had never modified or worked on the exhaust system. He assumed it came that way from the factory because it had been purchased new from a distributor and nobody had checked its condition against the Manual. They had not made any modifications or welds (he stated that he did not even know how to weld) and he also did not know what could have happened with the last weld in which a part had been freshly polished (prepared) and welded recently. The maintenance tasks were limited to replacing spark plugs, cleaning carbon deposits and he recalled that

[5] Refers to the other partner in the school, who was abroad and no longer worked as an instructor.

once they had replaced a part in the ignition system. The engine had not been taken to an authorized center because for this last task (on the ignition system), they had contacted the ROTAX authorized official workshop in Spain, which had a one-year waiting list. The overhaul in 2013 and 2014 had been done in Avila by a person who also maintained other aircraft and who had experience. They took it to him and after a few days were told it was ready. There was no record of any task in particular done on the engine, only that it had been "overhauled".

1.18.1.2 Statement from the student

The information provided by the student about the accident matched that given by the instructor.

1.18.1.3 Statement from aerodrome employee

This eyewitness stated that he was behind the hangars and thus could not see the runway from his position. He heard a bang and a sudden change in the aircraft's engine RPMs. When he looked he saw several maintenance technicians who were outside their company's hangar where they were working on a helicopter (near the taxiway) rushing to the place where he assumed the aircraft had gone down. They were carrying a fire extinguisher to aid the victims in case there was a fire. In the end there was no fire. They found the elbow from the exhaust system on the taxiway near the location of the helicopter that the technicians were working on, and over 100 meters away from the site where the aircraft came to a stop.

1.18.1.4 Statement from eyewitness (maintenance technician)

One of the mechanics stated that he was working on a helicopter when he heard an engine that sounded very bad (misfiring/backfiring), so he stopped to look at it. After about five seconds, he saw part of the exhaust system strike the propeller blades. He could not tell whether the aircraft was taking off or landing, but it was 30 to 40 m above the runway and descending at a high pitch angle, practically nose diving, though he could still hear the engine running.

1.18.2 Information on the exhaust

According to the engine manufacturer's (ROTAX) Installation Manual and Maintenance Manual, the standard version of the engine included a basic exhaust system (48-kW 582 UL mod 90/99 engine). There was another version of the engine with exhaust noise reduction (40-kW 582 UL engine) that added an after-muffler (optional system considered in the Maintenance Manual). The accident aircraft had this system installed.

This Maintenance Manual (see Appendix C) warned that any change to the original exhaust system could seriously degrade the engine's performance, reliability, life, fuel economy and noise reduction ability, and that improper handling or modifications could damage the engine. The engine manufacturer stated that if modifications were unavoidable, a certain minimum separation distance had to be observed, while other necessary modifications required its written approval. The installation of springs to allow dampening of the system was also contained in this section on the exhaust.

For the version with the noise reduction installed, it provided the instructions on how it should be installed. The most relevant aspects in this regard are detailed below.

- The union elbow between the muffler and the after-muffler must be attached to these two parts by means of clamps.

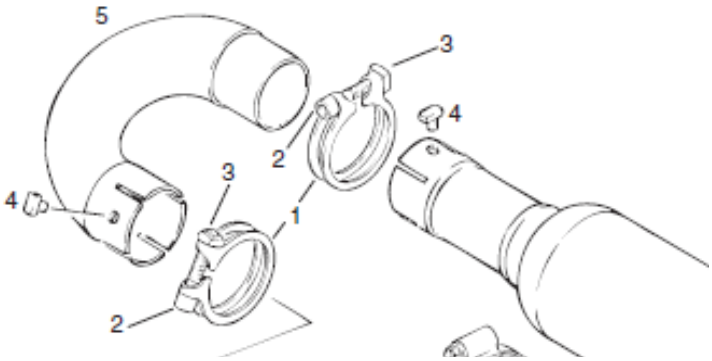


Figure 1. Union elbow assembly

- The ends of both the elbow and the after-muffler must be drilled to allow inserting a fastening pin to hold the clamps mentioned above.

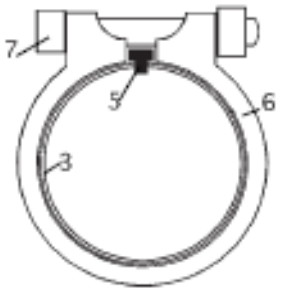


Figure 2. Position of securing pin

- A butterfly-shaped part supports the muffler and after-muffler to avoid vibrations. This part is attached to each of the components using clamps.

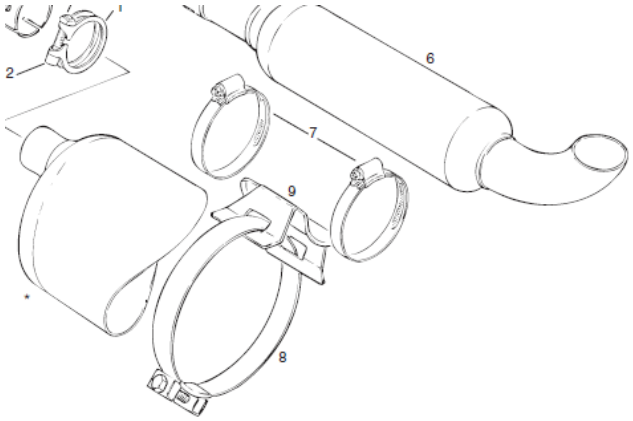


Figure 3. Layout and attachment of muffler and after-muffler

The Illustrated Parts Catalog (IPC), not included in the information provided to the aircraft owner, also specified the difference between the standard and noise-reduction versions of the engine: "Exhaust system: standard version (48 KW) or version of reduce noise emission (40kW) as optional extra only at 582 UL DCDI"

It also stated that for the standard version, there were three possible exhaust configurations: sidemount, 90° and straight.

582 UL 40 kW	-
582 UL mod. 90/99 DCDI 48 kW	SIDEMOUNT
	1 X 90° 2)
	GERADE / STRAIGHT

Table 1. Exhaust types by engine model

The reduced-noise version only allowed the sidemount arrangement with the added structure of the after-muffler (described earlier in this section).

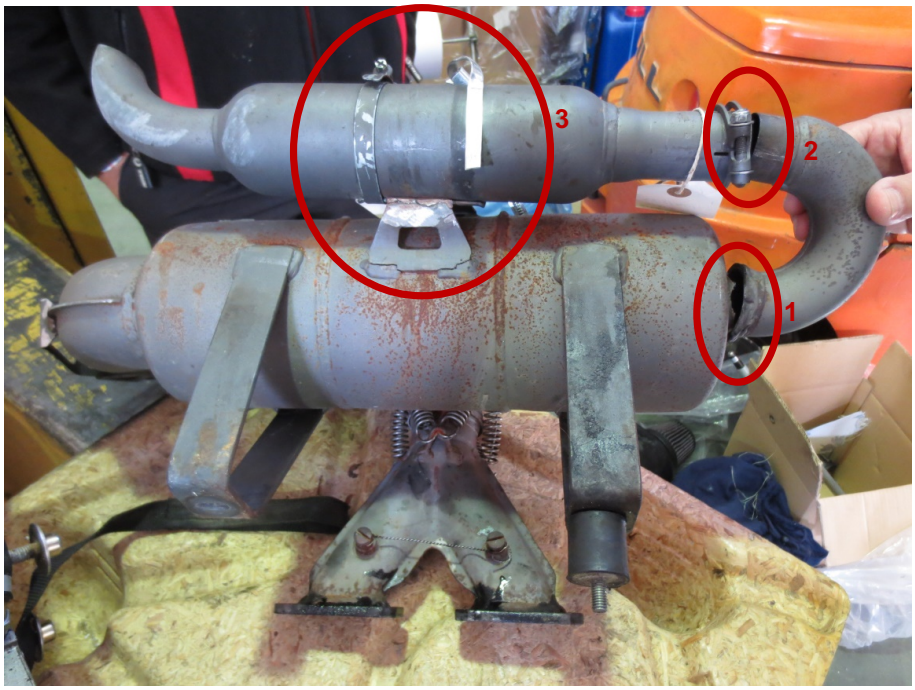
1.18.3 Engine inspection

The engine, and the exhaust system in particular, were inspected after the accident in the workshop.

In general no abnormalities were observed in the operation of the engine's components: valve closing, crankshaft rotation, timing, spark plugs, ignition system and the condition of the carburetors.

There was some evidence of leaks in the exhaust that suggested the absence of a good alignment between the engine block (cylinder outlet) and the exhaust.

When the exhaust system was checked as a whole, there were differences from the manufacturer's specifications (see Photograph 7):

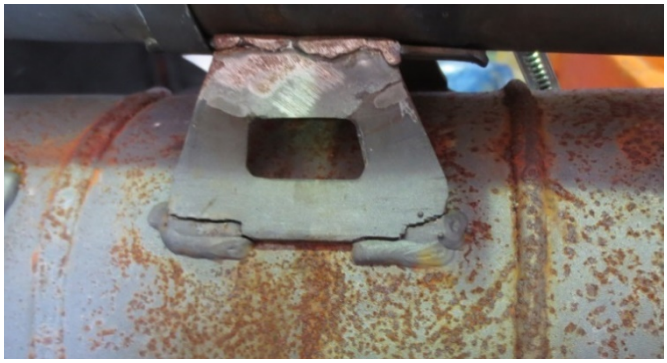


Photograph 7. Reconstruction of the aircraft's exhaust system

- The end of the muffler (1) was sheared and the elbow had been shortened where it meets the muffler. Instead of being attached using a clamp and pin, it had been welded directly.

Photograph 8. Comparison between the elbow on the accident aircraft's exhaust and a new replacement elbow

- The other end of the elbow, where it attaches to the after-muffler, was not secured using the pin, nor had it been drilled as described by the engine manufacturer (2).
- The butterfly-shaped part which supports the muffler and the after-muffler was welded to the muffler and supported by the after-muffler, to which it was attached using clamps (3).
- One of the wings on the butterfly had recently been sanded, prepared and welded again (3) presumably during last overhaul. According to expert personnel this welding has been properly done.

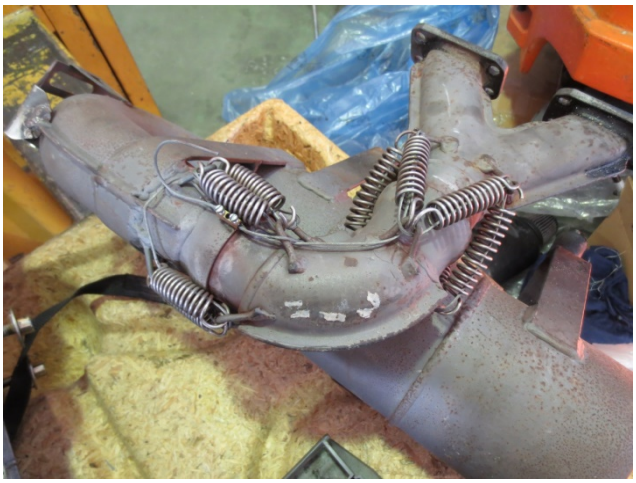


Photograph 9. Close-up of the recently prepared (sanded) and welded butterfly wing

- The clamp holding the after-muffler to the butterfly that had been installed the day before and that had broken during the accident consisted of two smaller clamps joined together.

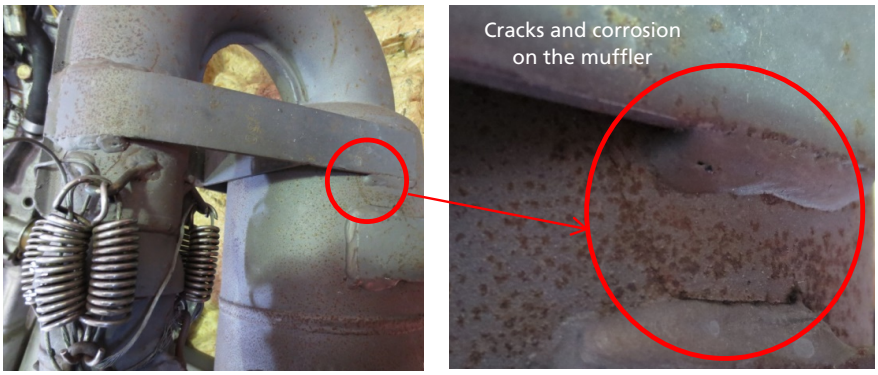
Photograph 10. Close-up of the cable tie replaced the day before the accident

- There was twice the number of springs specified by the engine manufacturer in the part where the outlet of the engine block is connected to the muffler. There was also a wire connecting all the springs.



Photograph 11. Close-up of the multiple springs and the wire connecting them

- There were cracks and signs of corrosion in the muffler.



Photograph 12. Close-up of the cracks and corrosion on the muffler

Initially it appeared that all the modifications to the exhaust system had been carried out by the owner, since there was a recent weld and components were added not provided by the manufacturer (like the wire that connected all the springs). After asking the owner about these modifications, he stated that it had been received like that from the distributor, and he thus assumed it came that way from the factory (see Section 1.18.1.1 Statement from the instructor).

To corroborate his statement, the owner sent a photograph of the aircraft right after it was purchased (see Photograph 13).

Photograph 13. Exhaust system on the aircraft just after it was purchased

The arrangement of the exhaust components was verified to be the same, though it was different from that specified by the manufacturer. The distributor said that the aircraft were assembled and tested in France, and in Spain they only underwent a test flight prior to being registered.

1.18.4 Information from the aircraft manufacturer (Air Création) and the engine manufacturer (ROTAX)

The engine manufacturer was contacted to inform of the anomalies and modifications detected during the inspection, and to ask about the viability of the modifications and alternate arrangements of the exhaust system compared to those described in the manuals. The engine manufacturer replied that the exhaust system on the ROTAX 582 was designed for this engine and its characteristics. The modifications present on the accident aircraft engine did not comply with the ROTAX installation manual (Chapter 10 - Exhaust system), and any modification made by the aircraft owner, installer or manufacturer could affect the stress placed on the exhaust system. In its opinion, the aircraft manufacturer was responsible for the design and installation of the entire exhaust system and had to prove the operability and integrity of the system if any modifications were made.

Similarly, the aircraft manufacturer (Air Création) was asked about the reason for the modifications made to the exhaust system, since it does not seem that the original exhaust system with the after-muffler option obstructed or interfered with any other system on the aircraft (see Figure 2). The manufacturer stated that the change was made primarily due to safety reasons, to allow the use of "extra-silent"

propellers with longer blades, since if the silent blocks[6] or other fixed parts of the exhaust broke, there had to be a certain distance to the propeller. The manufacturer was also not satisfied with the fastening clamps since they broke or were lost easily over time, which is why the elbow had been welded on. It stated that this assembly had been used for over twenty years on its various trikes (over 500 aircraft made with no problems reported involving the exhaust system installed), until production stopped five years ago. This aircraft had also been flight tested at the factory for at least 100 hours before production was commenced. The manufacturer assured that as a general rule, it adhered to ROTAX's guidelines, except when it needed something that was better suited to its aircraft models. It also stated that there was no regulation in France specific to this issue, and that it had observed ULM regulations, which state that a ULM manufacturer can design its own exhaust system if so required for some reason. Such was the case with this aircraft, since the model proposed by ROTAX was not suited to every configuration and there was no specific documentation in this regard.

The aircraft manufacturer further stated that when the mount for the exhaust system was designed, it contacted ROTAX, as per its request (to consult with it regarding any modifications to the exhaust system, as they could degrade the performance, reliability and life of the engine), and ROTAX had no objections. There is no written record of its approval, though Air Création also believed that it had not actually made any changes to the basic/standard exhaust system per se (as described by ROTAX), but rather to the after-muffler, which was an optional addition to the engine/exhaust assembly. In principle, this change, in its opinion, should not have affected the performance or the way in which the user of the aircraft could perform the maintenance inspections ("Check the exhaust system before every flight for tensioning, physical damage or changes in the sound pattern. In particular, inspect the springs and hooks").

1.18.5 Safety actions taken by the aircraft manufacturer (Air Création)

This Commision was informed during the process of comments on this report that the manufacturer of the aircraft (Air Creation) was preparing a Service Bulletin so as to issued (See Appendix D). This SB will be focused on the risk of exhaust system failure and will remind the operators the importance of carrying an appropriate inspection and maintenance of this system.

1.18.6 Information provided when purchasing the aircraft

The documentation provided by the distributor (and by the aircraft manufacturer) to the owner included:

[6] Shock absorbing blocks installed between the engine and aircraft structure to help absorb vibrations.

- Instruction and maintenance manual for the KISS 450 wing
- Instruction and maintenance manual for the GTE 582 S tricycle
- Operator's Manual for 582 UL engines
- Maintenance Manual for the 582 UL series

- Section 10.2. of the engine Maintenance Manual has a table with the necessary maintenance schedule (see Appendix 2) that contains the following tasks and checks associated with the exhaust system: 13. Replace exhaust muffler springs (every 75, 150 and 225 hours). Task 38 requires overhauling the engine every 300 hours, with a footnote specifying a frequency of 300 hours or 5 years, whichever comes first, and instructing to contact an authorized distributor or service center.

- The Instruction and Maintenance Manual for GTE 582 S trikes specified the following in point c) on the pre-flight inspection: Verify the condition of the propeller, exhaust and its fastening springs, air filter and the silent blocks.

  In the maintenance section, it stated to use the attached ROTAX manual to maintain the engine, and independently to:

  - Among other things, replace the spark plugs and inspect the exhaust pipe every 10 flight hours.
  - Replace the silent blocks on the engine and exhaust every 50 hours.

  This Manual also stated that the aircraft had the series I pack as an option, which included the after-muffler as well as other components.

  On its past page, it also included a table with periodic checks with spaces to record the date and flight hours of the checks.

- The Operator's Manual contained the pre-flight checks to conduct on the engine, including the following item: "*Check the exhaust for cracks, for the safety of the assembly, for broken and worn springs and hooks, verify the lock wiring on the springs*."

Neither the Installation Manual nor the Illustrated Parts Catalog, which showed how the exhaust system is installed (see Appendix 2 for example), was supplied to the operator.

1.18.7 Information on the AESA Aircraft Type Certificate

Before a new aircraft model design can go into operation, it must be granted a Type Certificate by the relevant authority. This document certifies that said aircraft design and its configuration satisfies the relevant airworthiness/safety requirements applicable to it.

The aircraft had an AESA Type Certificate. According to the datasheet for Type Airworthiness Certificate no. 191-I/2, it was originally issued by the DGAC and carried over by AESA. As a result, AESA was asked for the certification criteria to check if the Type Certificate had been approved with the engine exhaust modification, or if the modification was added to the original Type Certificate. AESA replied that the criteria used during the process to certify the AIR CREATION KISS 450 GTE 582S aircraft, as well as other ULM aircraft, consisted of accepting the engine proposed by the design department of the organization requesting the Type Certificate, and later including in the datasheets attached to the Type Certificate the main characteristics provided by the engine manufacturer (number of carburetors/ cylinders, muffler, ignition, type of starter, type of cooling, maximum power/RPMs, type of gearbox). Details such as the type of exhaust system are not included. Given these basic characteristics, the engine manufacturer might include others of minor importance that do not affect the basic characteristics given for the engine and intended to be representative for the engine model.

AESA also reported that the official ROTAX distributor in Spain had informed AESA that three exhaust systems were approved for this engine model, and that changing between any of them should not affect the basic data contained in the aircraft datasheet. In AESA's opinion, it would be difficult to detect if the ROTAX exhaust were replaced by another system that is also accepted by the manufacturer since, in theory, any of the exhaust systems accepted by ROTAX for this engine could be installed.

1.18.8 Information on ULM regulations

The regulation on ULMs is national in its scope, there being no European regulation in this area. According to the ULM Certification Requirements, ORDER of 14 November 1988, which lays out the airworthiness requirements for powered ultralights (ULM) (BOE no. 277 of 18 November 1988), the following apply:

Article 10. Minimum documentation that the builder must deliver to the user.
The following minimum documentation shall be delivered to the user with each aircraft:

a) A User's Manual describing:

- Normal procedures.

- Operating limits.
- Emergency procedures.
- Performance.
- Weight and balance limits, including instructions for adjusting them.
- Allowed fuels and lubricants.
- Assembly, disassembly and storage procedures.
- Instructions for periodic maintenance indicating the most important tasks to be carried out to ensure the airworthiness of the vehicle; in particular, how to maintain the anchor points for the elements that provide lift, the engine and the landing gear.

b) A maintenance manual for the user to log important operations affecting maintenance, such as assembly, disassembly, propeller or engine replacements or repairs. The entry shall include the date and hours of operation when the activity takes place.

According to Article 12 of this Order, "Continuing Airworthiness", the owner shall be fully responsible for maintaining and preserving the airworthiness of the aircraft [...].

In France, ultralight aircraft are delivered a "permit to fly" by DGAC, and not a type certificate. This permit is based on a declarative report. In particular, there is no requirement in terms of continued airworthiness.

1.19. Useful or effective investigation techniques

N/A.

2. ANALYSIS

2.1. General aspects

The aircraft's occupants, an instructor and a student, had been flying for approximately one hour, performing different maneuvers in preparation for the student's exam, which was scheduled for the following week. After these maneuvers they did a touch and go on runway 26, and as they were climbing, the occupants heard a noise and saw something they could not identify detach and strike the propeller blades. The student yielded the controls to the instructor, who tried to fly straight to the end of the runway, where there were some shrubs that he hoped would cushion the impact. Instead, despite the instructor's efforts to steer the aircraft, it started veering to the left without gaining altitude, since he had no control over the aircraft because of not having sufficient aerodynamic speed and because the sail (the aircraft's wing) was not tensioned. Eventually the main gear ran into a stack of metal sheets piled in a part of the aerodrome containing scrap metal and the aircraft impacted the ground.

The aircraft had flown an average of five hours a month in 2015. The student had 27:30 hours of flight time, including 8:17 solo hours. He had flown for 45 minutes the day before, but not since October 2014 prior to that because, as he stated, AESA did not have any examiners available. He was finally assigned an examiner for 30 April 2015.

The instructor and student stated that both had checked the exhaust system during the pre-flight inspection of the aircraft. The previous afternoon they had noticed that one of the clamps holding together two parts of the exhaust (the muffler and after-muffler) was missing, and that there was a small crack in the butterfly-shaped part that supports these two parts. The decision was made to replace the clamp with two shorter clamps, believing this was sufficient, but this clamp did not conform to the manufacturer's specifications. It could not be determined whether the butterfly-shaped part broke in the area where the crack was found. All of these facts point to a lack of a maintenance culture and of maintaining airworthiness. The exhaust system may have been subjected to additional stresses the previous day and potentially damaged as a result of the missing clamp.

During the field investigation, the recently replaced clamp and the after-muffler were found on the ground between the runway in use and the taxiway. Aerodrome personnel had already picked up the elbow that connected the muffler and the after-muffler on the taxiway. All of these parts were along the path that was likely taken by the aircraft after diverting from its takeoff trajectory (see Appendix A).

2.2. Aspects of the assembly and design of the exhaust system

When the engine and exhaust system were being inspected in the workshop, it was discovered that the exhaust system was not as specified by the engine manufacturer ROTAX in its manuals. The standard engine version offered three different exhaust systems to choose from (sidemount, 1x90º and straight). The accident aircraft had an engine variant with the noise reduction system (ROTAX 582 UL 40-kW engine), which featured an optional after-muffler added to the standard variant (ROTAX 582 UL mod 90/99 40-kW engine). This variant with noise reduction only accepted the sidemount exhaust with the optional after-muffler.

On this variant, the ends on both the elbow and the after-muffler had to be drilled to allow the installation of a fastening pin to allow attaching the clamps, but on the accident aircraft the end of the elbow that was attached to the muffler had been shortened and welded to the muffler, and there was no fastening pin on the other end, which attached to the after-muffler. The butterfly-shaped part that supported the muffler and after-muffler to prevent vibrations had been welded on, instead of being attached to the muffler with a clamp. There were also twice as many springs as there should have been, and the springs were all attached to one another using a wire.

The owner stated that he had not modified or welded anything on the exhaust system and that he had only replaced the clamp that was discovered missing the day before the accident flight. The Installation Manual and the Illustrated Parts Catalog, which showed how the exhaust system was installed, were not supplied to the operator with the purchase, thus making it impossible to check the system for modifications. It was checked by a photograph of the newly purchased aircraft that the system had been installed like that from the factory and that it has been made by the aircraft manufacturer (Air Création), which reported that it had made the changes for safety reasons; namely, to allow the use of "extra-silent" blades and to avoid the use of clamps that, in its opinion, were easily lost or broken. The aircraft manufacturer stated that, as a general rule, it adhered to ROTAX's guidelines, except when they needed something that was better suited to their aircraft models. In this case, Air Création stated that its modifications were supported by the aircraft's testing period prior to production (over 100 hours), and that they sold over 500 aircraft with this engine configuration which had been flying for over 20 years with no problems reported. The manufacturer was also of the opinion that the changes had not actually been made to the basic/standard exhaust system as described by ROTAX, but to the after-muffler, which was an optional device to reduce noise. In theory, this change should not affect either the performance or maintenance of the system. In this regard, the Commission believes that cutting off the end of the standard exhaust and directly welding it to the elbow connecting it to the after-muffler does constitute a modification of the standard exhaust system.

The Installation Manual warned that any change to the original system could seriously degrade performance, reliability, engine life, fuel economy and the noise reduction capability of the engine, and that improper handling or modification of the engine could damage it. It also stated that any unavoidable modifications had to maintain a minimum separation distance, and that necessary modifications must be approved in writing by the engine manufacturer. ROTAX was asked about the viability of modifications to and arrangements of the exhaust system different from those specified in its manual. The engine manufacturer replied that the exhaust system on the ROTAX 582 was designed for that engine and its characteristics. The modifications made to the engine on the accident aircraft were not in compliance with the Installation Manual, and any change made by the aircraft's owner, installer or manufacturer could affect the stress placed on the exhaust system. In its opinion, if modifications are made to the system, the aircraft manufacturer would be responsible for the design and installation of the entire exhaust system, and would have to demonstrate its operability and integrity.

The exhaust system as modified by the aircraft manufacturer (Air Création) did not comply with the specifications contained in the engine manufacturer's (ROTAX) documentation, and ROTAX had not approved these modifications in writing. There is no record of any studies conducted by the aircraft manufacturer that demonstrate the safety of the modified exhaust system, except for the tests run on the aircraft prior to production and the absence of any problems reported to date involving the exhaust. This Commission is of the opinion that any modification made to the exhaust system, instead of allowing more freedom of movement and dampening vibrations, actually make the assembly stiffer. This is confirmed by the fact that the exhaust system components that broke during the accident did so at the welds made when the aircraft was built. The aircraft manufacturer issued a Service Bulletin focused on alerting on the risk of exhaust system failure and on reminding the operators the importance of carrying an appropriate inspection and maintenance of this system. Although this action is valuated, this Commission considers that this action does not confront the fact that the design of the exhaust system does not comply with the requirements from engine manufacturer nor demonstrates the operability and integrity of the modified system. As a result, a safety recommendation is issued, as detailed later in this report.

2.3. Maintenance Aspects

The Maintenance Manual for the engine, supplied to the operator by the distributor, had a table with the required maintenance schedule. For the exhaust system, it specified several tasks involving replacing the springs in this system (every 75, 150 and 225 hours) and an overhaul every 300 hours, which included a note instructing that it be done every 5 years or 300 hours, whichever came first, by an authorized distributor or service center.

The instructor filled out a sheet with the maintenance tasks that were performed on the aircraft. These entries started on 6 July 2013 and ended on 28 March 2015. No information on the maintenance prior to this date was available. In general, they cleaned and replaced the spark plugs, cleaned off carbon deposits and did tasks to correct specific faults. In July 2013 and 2014 (with 550 and 693 hours on the engine, respectively), the engine was overhauled. The tasks logged by the owner did not match those specified in the table in the Maintenance Manual. The tasks logged made no reference to the exhaust system (or to the recent weld to the butterfly-shaped part). Neither of the overhauls specified the maintenance performed during these inspections, and they were not carried out at the manufacturer's service center because, according to the owner, there was a year-long waiting list. The 2013 overhaul was done in Ávila by an experienced mechanic who maintained other aircraft. The engine was delivered to him, and within a few days they were notified that it was ready.

The Instruction and Maintenance Manual for GTE 582 S tricycles supplied to the owner when the aircraft was purchased also made reference to an inspection of the exhaust, and on the last page included a table with periodic checks where the dates and flight hours when these checks were made could be annotated. This table was not filled out.

The Eolo Marketing S.L. school was authorized by AESA as a ULM Flight School, extended until 26 April 2015. The school had purchased the aircraft on 3 December 2009 and had been operating at the Casarrubios aerodrome since 1 March 2014. On 16 April 2015, AESA inspected the activities of the ULM flight school, which resulted in, among others, the following discrepancies:

- There is no aircraft maintenance program.
- There is no indication that an aircraft maintenance record book exists.

The regulation on ULMs is national in its scope, there being no European regulation in this area. According to the ULM Certification Requirements, ORDER of 14 November 1988, which lays out the airworthiness requirements for powered ultralights (ULM) (BOE no. 277 of 18 November 1988), the manufacturer must provide periodic maintenance instructions that indicate the most important tasks to be carried out to ensure the airworthiness of the vehicle, as well as a maintenance book in which the user shall log any important operations that affect maintenance. According to this Order, the owner shall be fully responsible for maintaining and preserving the airworthiness of the aircraft. Based on this regulation, the owner had available to him the maintenance schedules and tables for the aircraft and engine, even if they were not filled out. There is no explicit requirement to record maintenance tasks, except for those that are considered important, such as replacing the propeller or engine; nevertheless, if the operator/owner had carried out the

tasks specified in the maintenance tables, it is likely that the wear on the exhaust system clamps would have been detected and that actions could have been taken to keep the components from detaching. The owner had the maintenance schedule established by the manufacturers, and despite being legally responsible for maintaining and preserving the aircraft's airworthiness, he had not done so.

2.4. Aspects involving the Type Certificate

Before a new aircraft design can go into operation, the relevant authority must issue a Type Certificate for it. This document certifies that the aircraft's design and configuration comply with the relevant existing airworthiness/safety requirements.

The aircraft had a Type Certificate from AESA. According to the datasheet on Type Airworthiness Certificate no. 191-I/2, it was originally issued by the DGAC and carried over by AESA. AESA was asked for the certification criteria to check if the Type Certificate had been approved with the engine exhaust modification, or if the modification was added to the original Type Certificate. AESA replied that the criteria used during the process to certify the AIR CREATION KISS 450 GTE 582S aircraft, as well as other ULM aircraft, consisted of accepting the engine proposed by the design department of the organization requesting the Type Certificate, and later including in the datasheets attached to the Type Certificate the main characteristics provided by the engine manufacturer, with details such as the type of exhaust system not being included. Given these basic characteristics, the engine manufacturer might include others of minor importance that do not affect the basic characteristics given for the engine and intended to be representative for the engine model. The official ROTAX distributor in Spain informed AESA that three exhaust systems were approved for this engine model, and AESA is of the opinion that changing between any of them should not affect the basic data contained in the aircraft datasheet. In AESA's opinion, it would be difficult to detect if the ROTAX exhaust were replaced by another system that is also accepted by the manufacturer.

The ROTAX 582S engine is different in that the standard system includes the exhaust system. The version of the exhaust system with noise reduction is unique, and there are not three different types as referenced by AESA.

In this particular case, the aircraft manufacturer had modified the standard exhaust system to combine it with the optional after-muffler system. This modification altered the original engine configuration and directly affected the basic characteristics of this model, its reliability and the stresses placed on the exhaust system. The aircraft manufacturer had not demonstrated the proper operation and integrity of the modified system, nor had the modifications been approved in writing by the engine manufacturer. The authority also failed to detect these modifications when it issued the Type Certificate for the aircraft. This is indicative of a lack of oversight of the configuration by the authority, and as a result two safety recommendations are issued in this regard.

3. CONCLUSIONS

3.1. Findings

An analysis of all the available information yielded the following conclusions:

- The aircraft's documentation was valid and in force.
- The aircraft had been purchased new and had about 770 flight hours.
- The instructor had valid and in force licenses, ratings and medical certificates and 460 hours of flight time on the aircraft type.
- The student pilot had a valid and in force permit and medical certificate and 27 hours of flight time.
- The school, Eolo Marketing S.L., was an AESA-authorized ULM Flight School, its license being extended until 26 April 2015.
- The school was not very active and only had the accident aircraft.
- The previous afternoon an exhaust system clamp was found to be missing, and was replaced with two shorter clamps.
- The combination of these clamps was not approved by the manufacturer of the aircraft.
- A crack in a weld for the butterfly-shaped part was also detected and largely ignored.
- Part of the exhaust system detached and struck the propeller during the touch and go maneuver.
- It was not possible to determine if the butterfly-shaped part broke along the crack that was found.
- The owner had the engine and aircraft maintenance schedules supplied in the documentation from the distributor.
- The maintenance tasks logged did not match those specified in the maintenance program.
- The engine inspection revealed that the exhaust system had been modified.
- On this engine model, the standard exhaust is included as part of the engine, though a noise reduction system can be added as an optional component.
- The modifications were verified to have been carried out by the aircraft manufacturer.
- These modifications did not comply with the engine manufacturer's specifications.

- The aircraft manufacturer reported that the modification had been done for safety purposes to allow the use of "extra-silent" propellers.
- These modifications had not been approved by the engine manufacturer.
- The modifications involved shortened components, using welds instead of clamps, doubling the number of dampening springs and running a wire through all the springs.
- The engine manufacturer warned that any modification to the system could seriously affect the stress supported and the engine's performance, reliability and durability.
- The aircraft had a Type Certificate issued by the DGAC and carried over by AESA.

3.2. Causes

The accident occurred because part of the exhaust system struck the aircraft's propeller during the critical takeoff phase. Since the aircraft's aerodynamic speed was so low, the student and instructor were unable to control the aircraft, which started to turn left and lose altitude until it impacted a stack of metal sheets and then the ground. The exhaust system had been modified by the aircraft manufacturer, Air Création, in violation of the specifications established by the engine manufacturer, ROTAX. Despite this, the aircraft had a Type Certificate issued by AESA.

Contributing to the accident is the fact that the operator/owner did not perform the maintenance tasks specified in the Maintenance Manual that was supplied when the aircraft was purchased, and which may have detected the deterioration of the clamps and avoided the subsequent detachment of the exhaust components.

4. SAFETY RECOMMENDATIONS

The exhaust system as modified by the aircraft manufacturer (Air Création) did not comply with the specifications contained in the engine manufacturer's (ROTAX) documentation, and ROTAX had not approved these modifications in writing. Except for the pre-production tests conducted on the aircraft and the absence of any reports informing of problems with the exhaust, there are no studies conducted by the aircraft manufacturer that confirm the safety of the exhaust system's new design. CIAIAC considers that the modifications made to the exhaust system, instead of allowing some degree of movement and shock absorption, make the assembly more rigid, as confirmed by the fracture of the exhaust system components where they had been welded as per the modified design. As a result, the following safety recommendation is issued:

REC 06/17: It is recommended that the aircraft manufacturer, Air Création, specify the measures required to ensure that the exhaust systems on its aircraft comply with the specifications of the engine manufacturer, ROTAX, or failing this, that it prove the continuing airworthiness and the equivalent safety of any modifications made.

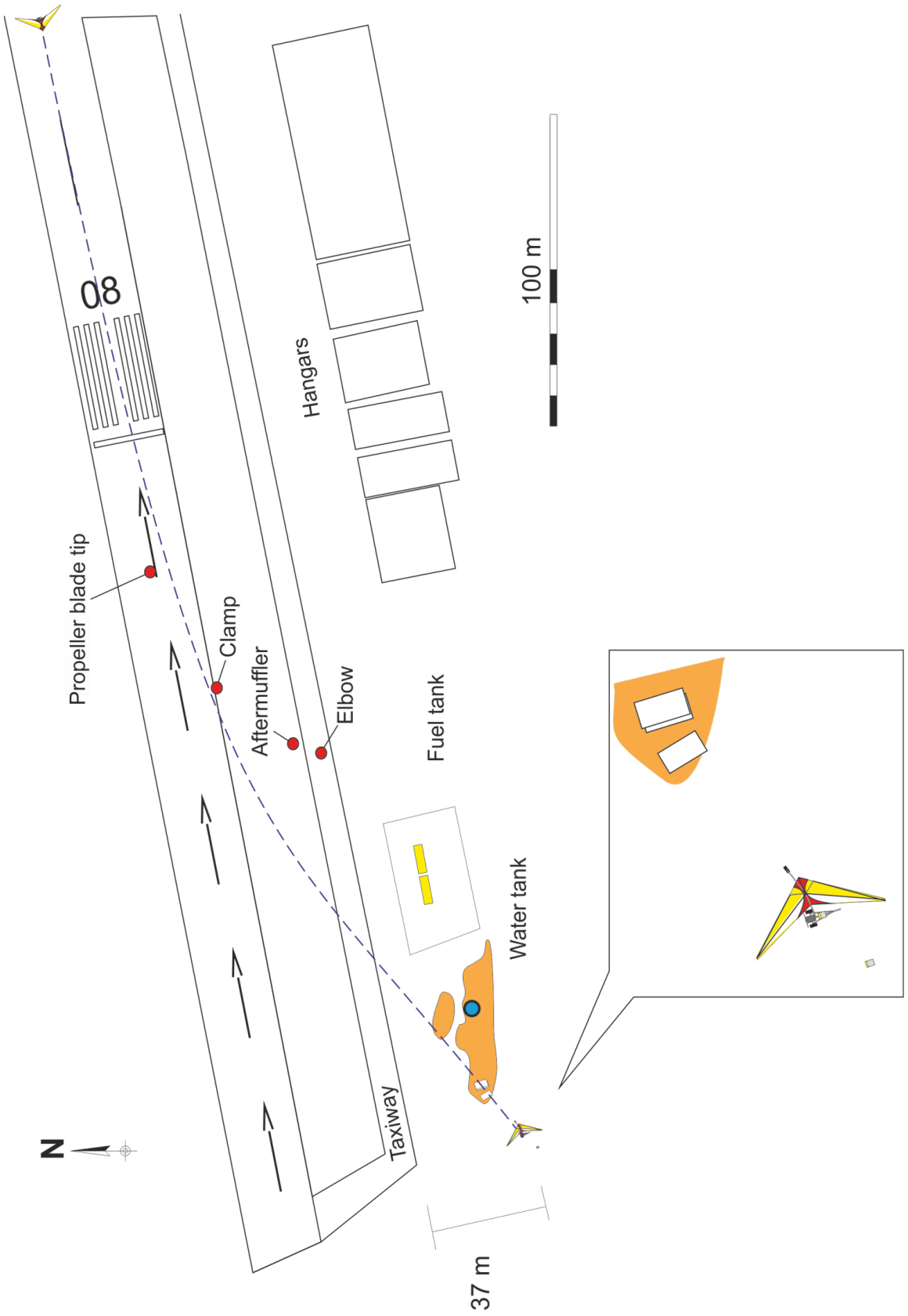
The aircraft had an AESA Type Certificate issued originally by the DGAC and carried over by AESA. Since neither the modification to the standard exhaust system (included in the engine model) nor the modified installation of the after-muffler system (without the engine manufacturer's approval) was detected when processing the Type Certificate or during its subsequent renewal, the following safety recommendations are issued:

REC 07/17: It is recommended that AESA evaluate the possibility of implementing a procedure to ensure that the aircraft's configuration is monitored as part of the process for issuing Type Certificates.

REC 08/17: It is recommended that AESA establish the measures necessary to inspect the exhaust systems on aircraft of this type registered in Spain so as to ensure that none of them is installed in a way that does not comply with the specifications established by the engine manufacturer, ROTAX.

APPENDIX A

FLIGHT PATH AND MARKS LEFT ON IMPACT


08
Hangars
100 m
Propeller blade tip
Clamp
Aftermuffler
Elbow
Fuel tank
Water tank
Taxiway
N
37 m

APPENDIX B

ENGINE MAINTENANCE INFORMATION

10.2) Maintenance Schedule

The following maintenance is planned and necessary for ROTAX 447 UL SCDI, 503 UL DCDI, 582 UL DCDI and 582 UL DCDI mod. 99:

	Checks and work	2 h	10 h	12,5 h	25 h	50 h	75 h	100 h	125 h	150 h	175 h	200 h	225 h	250 h	275 h	300 h	chapter	signature
1	Ground run				X												11.1	
2	Level check of liquids	X															11.2	
3	Retorque cylinder head nuts 1)	X															11.3	
4	Retorque exhaust manifold screws 1)	X	X														11.4	
5	Check rewind starter rope 10)			X													11.5	
6	Check electric starter gear					X		X		X		X		X			11.6	
7	Inspect spark plugs 10)			X													11.7	
8	Replace spark plugs				X	X	X	X	X	X	X	X	X	X	X		11.8	
9	Check ignition system				X												11.9	
10	Check and clean inside spark plug caps 10)			X													11.10	
11	Checking of V- belt tension		X		X	X	X	X	X	X	X	X	X	X	X		11.11	
12	Lubricate ball joints				X	X	X	X	X	X	X	X	X	X	X		11.12	
13	Replace exhaust muffler springs						X			X			X				11.13	
14	Lubricate control cables 3)				X	X	X	X	X	X	X	X	X	X	X		11.14	
15	Check propeller balance and tracking 2,3)				X	X	X	X	X	X	X	X	X	X	X		11.15	
16	Inspect propeller mounting bolts 3)																11.16	
17	Clean and oil air filter				X	X	X	X	X	X	X	X	X	X	X		11.17	
18	Check fuel filter				X	X	X		X	X	X		X	X	X		11.18	
19	Replace fuel filter							X									11.18	
20	Check carburetor(s) and re-adjust (idle speed, cable tension, ...)	X			X		X		X		X		X		X		11.19	
21	Clean carburetor(s) and check for wear					X		X		X		X		X			11.19	
22	Replace jet needle and needle jet									X							11.20	
23	Check fuel pump (measure fuel pressure)						X			X			X				11.21	
24	Check gearbox oil level				X	X	X		X	X	X		X	X	X		11.22	
25	Replace gearbox oil		X					X				X					11.22	
26	Check and adjust gearbox, preload of springs (type B gearbox)							X				X					11.23	
27	Replace rotary valve lubrication oil							X									11.24	
28	Inspect cylinder head and piston crown 4)					X		X		X		X		X			11.25	
29	Inspect piston rings for free movement 5)					X		X		X		X		X			11.26	
30	Check piston diameter 7)					X 6)		X 6)		X		X 6)		X			11.27	
31	Piston ring: check gap 7,11)					X 6)		X 6)		X		X 6)		X			11.28	
32	Piston ring: check axial clearance (rectang. Ring) 8,12)					X 6)		X 6)		X		X 6)		X			11.28	
33	Check cylinder diameter 7,11)					X 6)		X 6)		X		X 6)		X			11.29	
34	Cylinder: check for roundness 7,11)					X 6)		X 6)		X		X 6)		X			11.29	
35	Replace cylinder head-, cylinder base- and exhaust-gasket 8)					X 6)		X 6)		X		X 6)		X			11.30	
36	Inspect piston pin and bearing									X							11.31	
37	Inspect crankshaft and replace outer seals if necessary									X							11.32	
38	General overhaul of engine 9)															X	11.33	
	Checks and work	2 h	10 h	12,5 h	25 h	50 h	75 h	100 h	125 h	150 h	175 h	200 h	225 h	250 h	275 h	300 h		

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1) and after every replacement of gasket(s)
2) also after any damage
3) according to instructions of manufacturer
4) if carbon layer is more than 0,5 mm thick, decarbonize
5) if piston ring sticks clean and replace if necessary
6) if used in very dusty atmosphere
7) wear limit see Service Information 5 UL 91
8) If cylinder has been dismantled
9) To be carried out every five years or every 300 hours whichever comes first. contact authorized distributor or service center.
10) To be examined after every 12,5 hours of operation.
11 Necessary only if piston rings are not freely moving

APPENDIX C

EXHAUST SYSTEM INFORMATION

10) Exhaust system

▲ WARNING: Considerable effort has gone into the design of the ROTAX exhaust system. Any changes to the original system may severely deteriorate performance, reliability, engine life, fuel economy and ability of noise reduction. Improper handling or modification of the exhaust system as supplied could ruin the engine.

■ ATTENTION: Beware of any accessory systems that advertise an improvement over stock components.

The exhaust system is tuned for the respective engine and performance and must not be changed. If modifications are inevitable, then the mid length of inlet tube between exhaust flange and muffler must be maintained without fail (see ill. 7). For necessary modifications, ask for manufacturer's approval in writing. Check engine performance with serial exhaust system, prior to any modification.

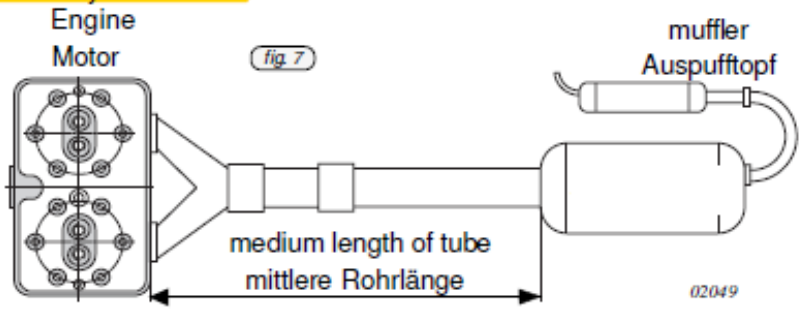

fig. 7

For engine type 582 UL DCDI 40 with reduced performance and noise emission an exhaust is offered that consists of items to be fitted by the aircraft manufacturer to suit the aircraft. Consult the respective parts list for parts needed.

■ ATTENTION: Pay special attention to maintain medium length of tubes. When using bent tubes, refer to length of centre line.

Engine type	medium length of tube
ROTAX 582, 40 kW	660 mm (26")

Check exhaust system prior to every flight for tightness, physical damage or changes in sound pattern. Especially inspect springs and hooks.

10.1) Installation of the exhaust system:

The muffler must be supported on vibration damping blocks. All ball joints must be greased regularly with heat resistant lubricant (e.g. LOCTITE Anti-Seize, 297 431) to avoid gripping or seizing of joints and consequent breaking of exhaust components.

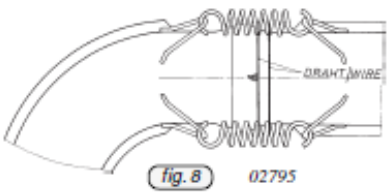

fig. 8

Springs used on exhaust system must be secured against loss and vibration (see Service Information 11 UL 87-E, page 5).

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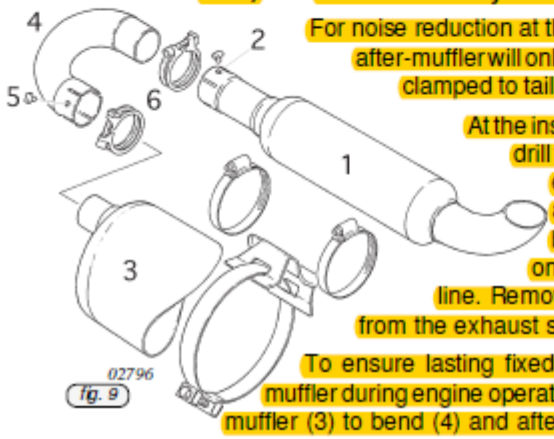
■ ATTENTION: Vibration due to improper suspension is by far the most common reason for damage to the exhaust system.

▲ WARNING: Don't use any sharp tool for removal of the tension spring for reason of possible damage of spring wire. A hook bent out of a 5 mm Ø bar is the most suitable tool.

◆ NOTE: Ensure that exhaust system is properly supported and maintained.

10.2) After-muffler system:

For noise reduction at the tail pipe, an after-muffler can be fitted. This after-muffler will only slightly affect engine performance and can be clamped to tail pipe of muffler.

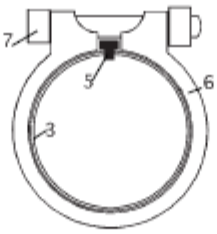


02796
fig. 9

At the installation of the after-muffler (1) in final position, drill the two 5,7 mm Ø holes in the bend and muffler end-pipe, for securing pin (5). The outer situated holes (2) have been already machined on the serial production line. Remove accumulated chips from the exhaust system.

To ensure lasting fixed position of the after-muffler during engine operation, the connections of muffler (3) to bend (4) and after-muffler (1) are to be secured against twisting by the securing pin (5).

Fit clamp (6) in the specific position that the Allen screw (7) prevents the securing pin (5) from dropping out.

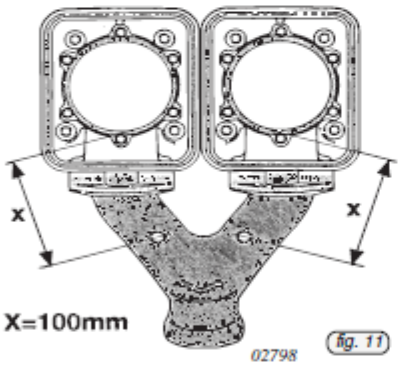


02797
fig. 10

10.3) Exhaust gas temperature (EGT):

Exhaust gas temperature will give the most rapid response in the event of improper mixture, pre-ignition or detonation. Ideally the exhaust temperature should be measured about 100 mm (4 in.) from the piston, with separate sensors for each cylinder.

EGT (max.) = 650 ° (1200 °F)



02798
fig. 11

■ ATTENTION: The exhaust manifold is provided with tapped holes. If the EGT is not measured the holes must be closed with screws which must be safety-wired.

800320

APPENDIX D

SERVICE BULLETIN

air crēation

BULLETIN DE SERVICE

KAIR 17001 – GTE 582

03 Fevrier 2017

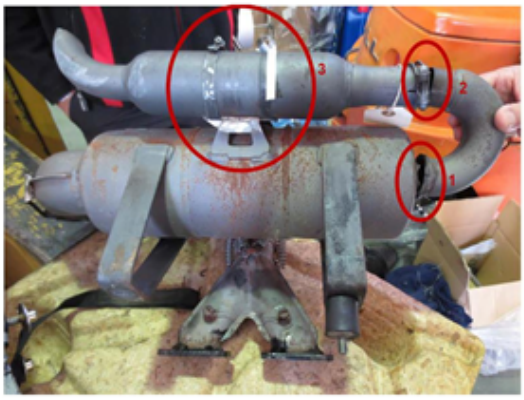
Sujet: Criques sur le système d'échappement des tricycles GTE 582

Modéles concernés: Tous les modèles GTE équipés du moteur Rotax 582

DESCRIPTION DU PROBLEME:
Apparition possible de criques sur les fixations du silencieux supplémentaire d'échappement (voir photo).
Suite à un accident survenu en Espagne, il a été constaté que le silencieux additionnel d'échappement s'est détaché en vol de l'échappement principal. Cette séparation a conduit l'échappement supplémentaire à percuter l'hélice, causant des dégâts catastrophiques aux pales.

CAUSE:
Les criques sur les fixations de l'échappement supplémentaire sont la conséquence des vibrations et des chocs thermiques. Ces facteurs de vieillissement sont ceux couramment rencontrés sur tout système d'échappement.

ACTION REQUISE:
Le vieillissement du système d'échappement doit être contrôlé de la manière suivante :
- Vérifier le système d'échappement et ses fixations avant tout vol.
- Pratiquer des inspections périodiques soigneuses comme indiqués dans les manuels (Air Création GTE503/582 notice d'utilisation et Rotax.582 manuel de maintenance).
Dans le cas ou des criques sont détectées, arrêter les vols et contacter notre service après-vente pour la réparation ou le remplacement des pièces.



1 : Criques possibles au niveau des soudures du coude à la sortie du silencieux principal

2 : Collier de serrage maintenant le silencieux additionnel sur le coude

3 : Criques possibles au niveau des soudures de la patte de fixation maintenant le silencieux additionnel

RAPPEL IMPORTANT :
Ne jamais voler avec une hélice deséquilibrée engendrant un niveau élevé de vibrations.
Contacter notre service après-vente pour la réparation où le remplacement de l'hélice.

air crēation - Aérodrome de Lanas 07200 AUBENAS – France 1/1
Tél : 33 (0)4 75 93 66 66 - Fax : 33 (0)4 75 35 04 03 - E-mail : info@aircreation.fr - Internet : www.aircreation.fr

APÉNDICE E

COMMENTS FROM BEA

Annex 1: Comments to the draft final report

This document compiles all the comments relating to the draft final report sent by CIAIAC on the accident to the Air Creation Kiss450 GTE582S / EC-LGM accident that occurred on 24 April 2015 at Casarrubios Aerodrome.

It contains 2 sections, as follows:

1. Section 1 contains general comments explaining the BEA's understanding of the event and its causes.
2. Section 2 contains comments on particular sections of the draft final report, which result from the first section.

1. General Comments

BEA agrees with the findings of your investigation regarding the modifications to the exhaust system carried out by the manufacturer. However, we do not think this modification is as preponderant in the accident as your report suggests it is. We also think some other aspects of this accident could benefit from further investigation or could be mentioned with more emphasis in your report.

Regarding the fractures identified on the exhaust system, we would like to bring some clarification to your attention. As mentioned in your report, several fractures have been identified on different areas of the exhaust:

- the end of the muffler;
- the wings on the butterfly;
- one clamp attachment.

The fractures at the end of the muffler and on the wings of the butterfly are located next to welded joints. The position of these fractures and their geometry seem to indicate that a phenomenon of fatigue occurred during the use of the aircraft. Taking into account these fatigue phenomena, it is difficult to think that these fractures could have propagated entirely during the last flight. This damage must have been present for several flight hours. A number of criteria could have led to the propagation of cracks:

1. In your draft report, you indicate that one of the wings of the butterfly had recently been sanded, prepared and welded again. It seems interesting to know if this new welding, that was not realized by the manufacturer, could have affected the material and decreased his mechanical characteristics.

Additionally, if this wing of the butterfly was welded again, this means that it should have been fractured before. Under this condition, it is essential to know the time during which the system was used with this fracture. Indeed, use with a fractured wing could generate vibrations and mechanical stresses on other areas of the exhaust.

2. You also indicate that one clamp holding the after-muffler to the butterfly had been installed the day before the accident. Similarly to the butterfly wing, it is very important to know the time during which the system was used with just one clamp because this could also have generated vibrations and mechanical stresses on other areas of the exhaust.

Metallurgical examinations of the fractures are necessary in order to determine if the fractures are indeed due to fatigue and to determine the causes of the fractures. There is no design that can totally prevent the appearance of cracks for the whole life of the system, especially without maintenance, because several factors such as the propeller balance or thermal shocks can induce the propagation of cracks. Without metallurgical examinations, BEA considers that it cannot be established as a fact that the failure has been caused by the modifications carried out by Air Creation. Besides, Air Creation has sold 517 flexwing aircraft equipped with this engine and with the same exhaust system since 1998 (see attached table), and none of its customers have ever reported fractures of the exhaust system similar to those of the accident.

Further to these technical considerations, the operational aspect of the accident is insufficiently explained in our opinion. A pilot who experiences a loss of power during the initial climb is supposed to have enough airspeed to keep control of its aircraft. This requires the pilot to react quickly and to keep a nose down pitch in order for the airspeed not to decrease, but it should not lead to a loss of control of the aircraft if the speed during the initial climb is appropriate. And for that accident, according to the manufacturer's experience, the scratch in the wing was too small to affect the wing's stability. However, other factors could explain the outcome of this event. For example, the vibrations due to the loss of a propeller blade that may have surprised and disturbed the pilots, or the instructor's reaction may have been delayed as the student had the controls at the time of the event, allowing the airspeed to decrease and making the aircraft more difficult to control. This aspect should be more developed for your report to be comprehensive, and this would require more detailed information from the pilots' interviews.

For these reasons, BEA is of the opinion that the primary cause of the accident is the fact that the pilots did not manage to keep control of the aircraft when a part of the exhaust system struck the propeller during the initial climb, causing a partial loss of power. Therefore, comment #21 in Section 2 of this document proposes a

reformulation of paragraph 3.2 corresponding to our understanding of the event.

In France, ultralight aircraft are delivered a "permit to fly" by DGAC, and not a type certificate. This permit is based on a declarative report. In particular, there is no requirement in terms of continued airworthiness. If the regulation is similar in Spain, that could partially explain why the maintenance was analyzed as inadequate and why AESA did not investigate the modifications brought by Air Creation to the exhaust system before delivering the type certificate.

As detailed above, we think that your safety recommendation for Air Creation is not supported by enough evidence that the modification contributed to the accident, and the in-service experience of the manufacturer tends to show that this modification does not lead to precocious failures when the aircraft is properly maintained. Consequently, BEA is of the opinion that this safety recommendation is inadequate. Considering the lack of regulation regarding ultralight aircraft maintenance and the fact that the operator is responsible for the airworthiness of its aircraft, it is suggested instead to recommend the Spanish operators to be informed of the ultralight aircraft regulatory status and therefore to adapt their maintenance and operations.

Besides, Air Creation will publish a Service Bulletin. This SB will focus on the risk of exhaust system failure and will remind the operators the importance of carrying an appropriate inspection and maintenance of this system.

We do not wish to comment the recommendations addressed to AESA as we believe the addressee will make its own comments.

2. Specific Comments

Lines with a grey background are editorial comments only.

	Draft Final Report Para.	Proposed amendment	Comments
	Please copy the paragraph from the draft final report here or the corresponding paragraph number that you wish to amend.	*Type your proposed amendment in the words you wish to be included in the report.*	*Please write down the reasoning or explanation for the amendment you are proposing in this column.*
1.	**p.6:** The investigation determined that the exhaust system outfitted by the aircraft manufacturer (Air Creation) did not conform to the requirements of the engine manufacturer (ROTAX). Contributing to the accident is the fact that the owner/ operator had not carried out the maintenance tasks specified in the Maintenance Manual, and which would have revealed the potential problems with the escape system components.	Contributing to the accident is the fact that the owner/ operator had not carried out the maintenance tasks specified in the Maintenance Manual, and which would have revealed the potential problems with the escape system components. Besides, the investigation determined that the exhaust system had been outfitted by the aircraft manufacturer (Air Creation) without coordination with the engine manufacturer (ROTAX).	As explained in section 1, the lack of maintenance is preponderant in this event. That is why we propose to mention it as the first contributing factor, and then mention the modification of the exhaust system, which by the way neither approved **nor forbidden** by the engine manufacturer.
2.	**p.7:** Since they had just taken off, he did not have enough speed to control the aircraft and the sail (the aircraft's wing) was not tensioned.	*Remove the first part of the sentence:* The instructor explains that he did not have enough speed to control the aircraft and the sail (the aircraft's wing) was not tensioned.	The word "Since" does not seem appropriate here, as even after takeoff they are supposed to have enough speed to control the aircraft. This point would probably require further explanation from the instructor.
3.	**p.8:** The instructor, [...], had a valid an in force TULM license.	The instructor, [...], had a valid and in force TULM license.	
4.	**p.9:** The aircraft had a Type Certificate of Airworthiness, no. 195-I/2, issued by the DGAC and held over by AESA.	The aircraft had a Type Certificate of Airworthiness, no. 195-I/2, issued by AESA on the basis of the identification card provided by the DGAC.	DGAC does not deliver Type Certificates of Airworthiness for ultralight aircraft. It delivers instead identification cards, which requires much less information from the aircraft manufacturer.

	Draft Final Report Para.	Proposed amendment	Comments
5.	**p.11:** The overhaul was not performed at an authorized center. The tasks logged did not make any reference to the exhaust system.	*Add the statement from the mechanics who performed the aircraft overhauls in 2013 and 2014.*	If possible, the statements from the mechanics who performed the overhauls would be very valuable. If their statements are not available, mention that you could not interview them.
6.	**p.13:** On the runway, one of the propeller blades and debris from the other blades were found starting at the displaced threshold markings (see Appendix A).	*Add the propeller blades debris on the drawing in Appendix 1.*	The propeller blades debris do not appear on the drawing in Appendix 1.
7.	**p.15:** The Eolo Marketing S.L. school was authorized by AESA as a ULM Flight School, extended until 26 April 2015.	The Eolo Marketing S.L. school was authorized by AESA as a ULM Flight School in 2014, extended until 26 April 2015. *Mention after this sentence the AESA requirements to authorize a flight school.*	As the results of the 2015 inspection are provided in your report, it would be interesting to know what was initially required by AESA to deliver the authorization to Eolo Marketing S.L. school in 2014, in order to compare the requirements for the initial authorization and the requirements for the inspection.
8.	**p.15:** The school was given 10 days to respond to these findings.	*Explain if the school responded to these findings or not, even if they responded only after the accident.*	
9.	**p.16:** The overhaul in 2013 had been done in Avila [...]	The overhaul in 2013 had been done with 550 hours on the engine in Avila [...]	Remind the reader the engine hours at the time of the overhaul.
10.	**p.16:** The overhaul in 2013 had been done in Avila by a person who also maintained other aircraft and who had experience.	*Mention where the overhaul has been done in 2014.*	

	Draft Final Report Para.	Proposed amendment	Comments
11.	**p.16:**	*Insert before chapter 1.18.2 a chapter explaining the ultralight aircraft regulation in Spain, in particular regarding the maintenance and certification. You might also want to explain the French regulation for ultralight aircraft certification.*	That could explain: - why the maintenance was not done according to the maintenance manual - why the manufacturer modified the exhaust system without formal approval of the engine manufacturer/AESA.
12.	**p.28:** [...] since he had no control over the aircraft by virtue of not having sufficient aerodynamic speed and because the sail (the aircraft's wing) was not tensioned.	[...] since he had no control over the aircraft because of not having sufficient aerodynamic speed and because the sail (the aircraft's wing) was not tensioned.	See comment #2. This point would require further explanation from the instructor.
13.	**p.19:** Chapter 1.18.3 Engine inspection	*If possible, provide in this chapter the results of metallurgical examination of the different fractures identified.*	As explained in section 1, a metallurgical examination is essential to determine the cause for the failure.
14.	**p.20:** One of the wings on the butterfly had recently been sanded, prepared and welded again	*Explain here if the welding had been done properly*	As explained in section 1, an incorrect welding can affect the material characteristics and thus contribute to the appearance of cracks.
15.	**p.29:** Air Creation stated that its modifications were supported by the aircraft's testing period prior to production (over 100 hours), and that this model had been flying for over 20 years with no problems reported.	Air Creation stated that its modifications were supported by the aircraft's testing period prior to production (over 100 hours), and that they sold 517 aircraft with this engine configuration, which have been flying for over 20 years with no problems reported.	As mentioned in section 1, 517 aircraft in service for over 20 years without problems reported on the exhaust system evidences that the exhaust system mounting designed by Air Création does not raise any safety issue. Thus it is important to mention these numbers here.

	Draft Final Report Para.	Proposed amendment	Comments
16.	**p.30:** This Commission is of the opinion that any modification made to the exhaust system, instead of allowing more freedom of movement and dampening vibrations, actually make the assembly stiffer. This is confirmed by the fact that the exhaust system components that broke during the accident did so at the welds made when the aircraft was built.	Remove the last sentence : This Commission <u>is of the opinion</u> that any modification made to the exhaust system, instead of allowing more freedom of movement and dampening vibrations, components that actually makes the exhaust system assembly stiffer. ~~This is confirmed by the fact that broke during the accident did so at the welds made when the aircraft was built.~~	The fact that the exhaust system components broke at the welds made by Air Creation only shows that the exhaust system had reached the end of its lifetime and should have been replaced earlier. Unless you prove that the original Rotax design with the clamps has a longer lifetime, the fact that it broke at the welds does not confirm that the modification makes the assembly stiffer.
17.	**p.30:** As a result, a safety recommendation is issued, as detailed later in this report.	*Remove this sentence*	As explained in section 1, BEA does not agree with this recommendation and proposes to remove it.
18.	**p.32:** [...], it was originally issued by the DGAC and carried over by AESA.	[...], DGAC originally issued an identification card which was carried over by AESA as a type certificate.	See comment #4.
19.	**p.34:** These modifications had not been approved by the engine manufacturer.	These modifications had not been coordinated with the engine manufacturer.	At least in France, an ultralight aircraft manufacturer is not required to obtain the manufacturer's approval in order to make modifications on the engine. Therefore the word "coordinated" seems more appropriate here.
20.	**p.35:** The aircraft had a Type Certificate issued by the DGAC and carried over by AESA.	The aircraft had a Type Certificate issued by AESA on the basis of the identification card provided by the DGAC.	See comment #4.

	Draft Final Report Para.	Proposed amendment	Comments
21.	**p.35:** The accident occurred because part of the exhaust system struck the aircraft's propeller during the critical takeoff phase. Since the aircraft's aerodynamic speed was so low, the student and instructor were unable to control the aircraft, which started to turn left and lose altitude until it impacted a stack of metal sheets and then the ground. The exhaust system had been modified by the aircraft manufacturer, Air Création, in violation of the specifications established by the engine manufacturer, ROTAX. Despite this, the aircraft had a Type Certificate issued by AESA. Contributing to the accident is the fact that the operator/ owner did not perform the maintenance tasks specified in the Maintenance Manual that was supplied when the aircraft was purchased, and which may have detected the deterioration of the clamps and avoided the subsequent detachment of the exhaust components.	A part of the exhaust system struck the aircraft's propeller during the initial climb. The loss of control occurred because the pilots did not manage to maintain enough airspeed. The investigation did not allow to determine how the aircraft reached such a low speed and then turned left and impacted a stack of metal sheets. The absence of maintenance is a factor that contributed to the accident by allowing the deterioration of the clamps and the subsequent detachment of the exhaust components. The exhaust system had been modified by the aircraft manufacturer, Air Création, without coordination with the engine manufacturer, ROTAX. Despite this, the aircraft had a Type Certificate issued by AESA.	As explained in section 1, this rewording of the conclusion corresponds to BEA's understanding of the event.
22.	**p.35:** After chapter 3.2 Causes	*Add a chapter "3.3 Safety actions taken by the manufacturer" and precise that Air Creation will publish a Service Bulletin. This SB will focus on the risk of exhaust system failure and will remind the operators the importance of carrying an appropriate inspection and maintenance of this system.*	

	Draft Final Report Para.	Proposed amendment	Comments
23.	**p.36:** First paragraph and first recommendation	*Remove the first paragraph and the first recommendation.*	See section 1 of this document for the reason for this proposition to remove the first safety recommendation.