aibn Accident Investigation Board Norway

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REPORT SL 2016/02

REPORT ON SERIOUS INCIDENT NEAR KLANTEN AIRFIELD, NORWAY ON 26 MAY 2015 WITH ALEXANDER SCHLEICHER GMBH & CO SEGELFLUGZEUGBAU ASK 21 MI, LN-GMI

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As accurate as the translation might be, the original Norwegian text takes precedence as the report of reference.

Photos: AIBN and Trond Isaksen/OSL

REPORT

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This investigation has had a limited scope, and the AIBN has therefore chosen to use a simplified report format. This report format, in accordance with the guidelines given in ICAO Annex 13, is only used when necessitated by the scope of the investigation.

All times given in this report are local time (UTC + 2 hours) unless otherwise stated.

Aircraft:	
- Type and reg.:	Alexander Schleicher GmbH & Co Segelflugzeugbau ASK 21 Mi, LN-GMI
- Year of manufacture:	2007
- Engine:	Austro Engine GmbH (previous Diamond) IAE 50R-AA, Serial number 2018
Operator:	Hallingdal Flyklubb
Date and time:	Tuesday, 26 May 2015 at 1300 hrs
Incident site:	North of Klanten airfield (ENKL), Norway
ATS airspace:	Uncontrolled airspace class G
Type of incident:	Serious incident, near-fire in engine installation
Flight type:	Private (club)
Weather conditions:	Not stated
Light conditions:	Daylight
Flight conditions:	VMC
Flight plan:	None
Persons on board:	1
Injuries:	None
Damage to aircraft:	Crack in the exhaust system. Heat damage to the engine installation and rear engine mounting.
Other damage:	None
Commander:	
- age:	53
- Licence:	Glider pilot licence with class 3 instructor privileges and a private pilot licence for powered airplanes (PPL(A))
- Pilot experience:	Total of 263 hours on gliders and approx. 185 hours on powered airplanes
Sources of information:	Reporting via form "Rapportering av ulykker og hendelser i sivil luftfart" (NF-2007) and the technical report from the glider mechanic, technical report from the Norwegian Glider Association's (S/NLF) Safety and Training Committee and the AIBN's own examination.

FACTUAL INFORMATION

History of the flight

The commander was going to conduct a ferry flight of LN-GMI from Otrøvatnet near the Tyin intersection to Klanten airport. Prior to the flight, he completed the daily aircraft inspection, including an inspection of the engine compartment and topping up the engine oil tank. The take-off and flight took place using the glider's built-in engine. After 25 minutes of flight, the low oil level warning came on in the cockpit, indicating that there was only enough oil for 10 minutes of flight. No other warnings were observed. The glider was then at an estimated altitude of 5,000 ft above Storfjorden (approx. 2,200 ft AGL). The commander therefore chose to let the engine run for another five minutes so that he could land at Klanten. The alternative would have been landing on the Tislei Fjord.

When the commander had stopped the engine, he tried retracting it half-way, to the cooling position. However, a fault in the engine controls caused the engine to start retracting fully. After a couple of attempts at running the engine in and out, he realised that reaching the runway would be difficult due to the drag generated by the extended engine. He therefore retracted the engine fully, slightly more than two minutes after it stopped. After landing, the commander extended the engine again, in accordance with the club's routines, to let it cool further down.

He was somewhat surprised that the oil tank could be almost empty. When he checked the oil tank level, he noticed that some oil had spilled in the oil tank area. To check how much was left, he refuelled and noted that it was only possible to refuel 1-2 dl of oil. He then notified the club that there may be a fault with the oil tank's level sensor.

In order to replace the level sensor, the engine had to be removed from the glider. During this process, it became apparent that the engine installation had been exposed to high temperatures and that there had been a near-fire. See page 4 for a detailed description of the damage.

The engine installation

The engine installation of the ASK 21 Mi is of a relatively unusual type. The engine itself is a Wankel engine installed in the fuselage behind the wing. When the engine is deployed, two doors open above the engine and the propeller and parts of the engine installation are extended.

Figure 1: Engine and propeller extended. Photo: Tønsberg Seilflyklubb

Figure 2: The engine installation. Photo: Alexander Schleicher GmbH & Co Segelflugzeugbau

The engine is liquid cooled, but the rotor is cooled and lubricated internally by air containing oil vapour. The air for the air cooling is pulled in by a fan (see Figure 3, Part 2) through a filter (Part 3) placed at the front of the oil tank (Part 4). Before the air enters the engine, oil is added from the oil tank (capacity of 0.73 l). After passing through the engine, the cooling air containing oil vapour goes via the pipe (Part 1) towards the rear and the exhaust silencer (Part 5). The pipe (Part 1) consists of two pipes, one passing inside the other. The innermost pipe carries exhaust from the engine. The air containing oil vapour goes through the outer pipe.

The exhaust silencer has an inner core directing the exhaust and an enclosing chamber where the cooling air containing oil vapour flows backwards. At the outlet (see Figure 2, Part 1), the exhaust pipe forms an ejector that contributes to extract the cooling air. Exhaust and cooling air are mixed in the ejector before the mixture exits the engine compartment to the open air. There is a heat shield around the exhaust silencer itself. This shield can be seen in Figures 2 and 3.

The engine is attached to the fuselage by two mounts in the rear and one in front. The rear mount includes a bolt going through the oil tank and down into the fuselage under the oil tank (see Figure 3, Part 6, and Figure 6).

The monitoring of the engine installation includes three temperature sensors:

- The cooling water temperature sensor. This triggers a warning (horn and flashing display) if it exceeds 105°C.
- Air sensor. A warning (horn and flashing display) is triggered if the temperature of the internal cooling air (ICAOut) exceeds 127°C
- Fire alarm (red flashing diode on the instrument panel). Triggers if the temperature inside the right side of the engine compartment exceeds 140°C

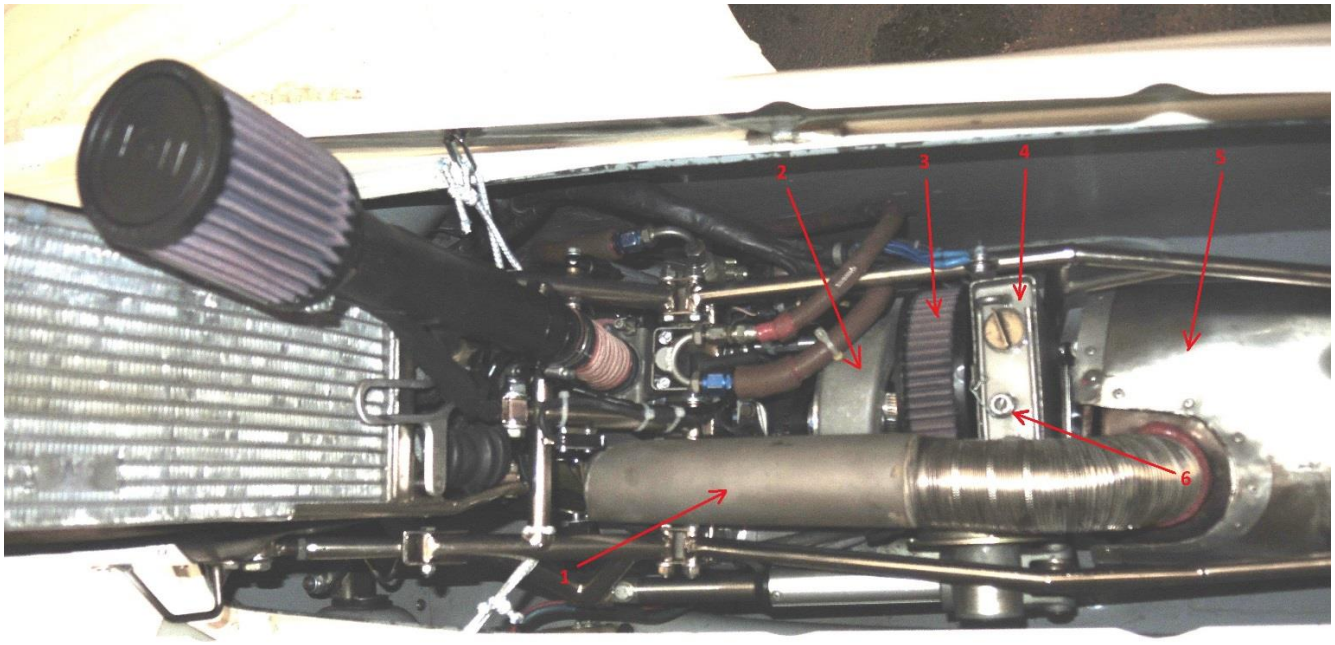

Figure 3: The engine installation seen from above. 1 Exhaust pipe, 2 Cooling fan, 3 Air filter, 4 Oil tank, 5 Exhaust silencer, 6 Rear engine mount bolt. Photo: AIBN

The aircraft's maintenance manual states that the engine must be inspected every 150 engine hours:

Disassemble and check exhaust silencer and its fairing.

When the incident occurred, the aircraft had flown 656 hours in total. The engine had then run 290 hours (tacho time) and made 1,253 starts. The following relevant maintenance had recently been executed on the engine installation:

- 5-year, 3-year and 150-hour inspection on 5 June 2013 at 226 engine hours. Replacement of the fan belt (see Figure 3, Part 2) and the water pump. The engine was taken out and the exhaust silencer inspected.
- Annual and 50-hour inspection on 15 March 2015 at 282 engine hours. The engine was taken out and the exhaust silencer inspected.

<u>Damage to the engine installation</u>

A glider mechanic with solid experience from the aircraft type took the engine out of the aircraft and conducted the technical examination following the incident. The following was observed:

- The air filter (see Figure 5) had been damaged by fire/overheating.
- The oil tank bore marks of having been exposed to high temperatures. The oil tank level sensor had been exposed to temperatures high enough to melt the epoxy holding it in place and cause an oil leak.
- The rear engine mount (see Figure 6) had been damaged by fire/overheating. The composite material in the glider fuselage had disintegrated due to the heat, causing the engine to come loose from the rear engine mount.
- The temperature in the oil tank area had been high, causing heat damage to various wires.
- Several details in connection with the exhaust silencer had been red-hot, or showed other signs of having been exposed to high temperatures.
- The exhaust silencer was cut open, and cracks and holes between the inner exhaust system and the surrounding cooling air were found (see Figure 4).

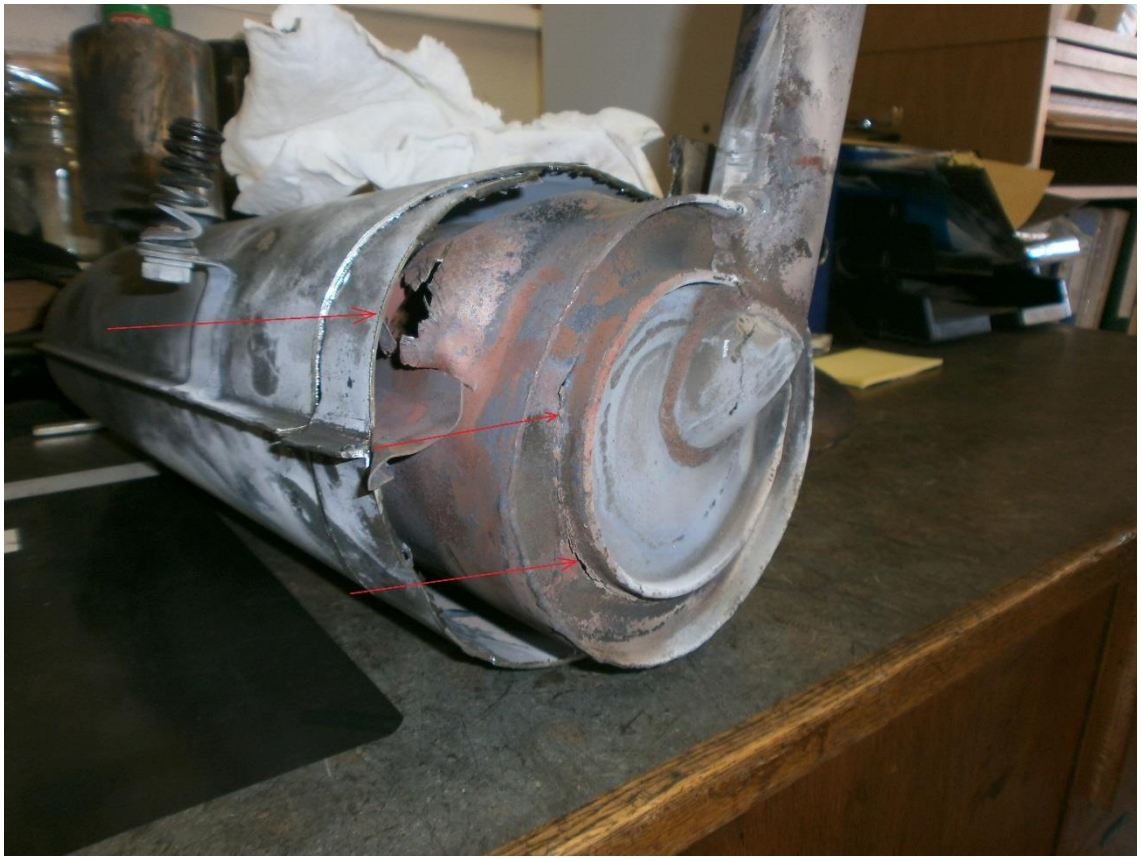

Figure 4: The exhaust silencer partially cut open. The external heat shield was first dismantled. The picture clearly shows the surrounding space where the cooling air passes through. The arrows indicate the cracks in the innermost element. Photo: S/NLF

Figure 5: Fire/heat damage on the air filter. The end wall of the filter has a concave deformation. Photo: S/NLF

Figure 6: Fire/heat damage to the oil tank and the area near the rear engine mount. Photo: S/NLF

Supplementary information

Alexander Schleicher GmbH & Co. Segelflugzeugbau ASK 21 Mi has EASA type certificate No. EASA.A.221, issued in March 2008. The basis for the certification is mainly JAR 22.

The Accident Investigation Board Norway (AIBN) has communicated the findings on LN-GMI to the glider manufacturer Alexander Schleicher GmbH & Co Segelflugzeugbau. The manufacturer stated that they were aware that the exhaust silencer had a limited life. The manufacturer has stated that cracks in the exhaust silencer will develop gradually. The following could indicate that the exhaust silencer was in the process of cracking before the situation became serious:

- Discolouring of the heat shield surrounding the exhaust silencer.
- Discolouring of the oil tank.
- Discolouring and damage to the protection paint on the inside of the engine compartment.
- A 10-15°C increase in the cooling air (ICAOut) temperature would reveal that something was wrong long before it had any serious consequences.

The aircraft's flight manual[1] contains no information that an increase in ICAOut can be a sign that cracks are in the process of forming in the exhaust silencer. The checklist for daily inspections makes no mention of discolouring. Pertinent items from the daily inspection checklist are quoted below:

> ***Daily Inspection with Extended Propeller***
>
> - - -
>
> *d) By pushing against the propeller assembly from the side and from the front, check the rubber elements of the engine mounting. The power-plant should react flexible and should not immediately move against the fuselage structure.*
>
> - - -
>
> *f) Inspect the mounting of the exhaust silencer. The spring mountings can be checked by shaking the silencer.*
>
> - - -

[1] Dated 1 December 2007. The Flight Manual has not been revised since it was published.

> ***Tank System (fuel and oil)***
>
> - - -
>
> *f) Check engine oil tank (between engine and exhaust silencer) for signs of leakage. Level check! Sufficient oil usage? (See also Section 7.8).*
>
> - - -

The glider mechanic was very experienced in relation to LN-GMI. He informed the AIBN that both the exhaust silencer and oil tank had been discoloured in some places for years before the incident occurred. This was considered normal by the users. This was why no-one reacted during the daily inspections. The pertinent item in the daily inspection checklist did not give any warning that discolouring in the area could be a sign that a fault was developing in the exhaust silencer.

The glider mechanic believed that a temperature sensor on the oil tank would provide additional safety against a recurrence. Such a sensor will therefore be installed on LN-GMI.

The manufacturer stated that they had improved the engine installation design in the glider models ASH 30 Mi and ASG 32 Mi. They plan to transfer these design improvements to ASK 21 Mi as well. The manufacturer was of the opinion that the problems with LN-GMI should have been detected earlier during thorough daily inspections. They therefore saw no reason to immediately revise the flight manual. However, lessons learned from the incident would be incorporated in future revisions.

THE ASSESSMENT OF THE ACCIDENT INVESTIGATION BOARD NORWAY

The Accident Investigation Board Norway believes that the heat damage in the engine installation originated in the cracks that formed in the exhaust silencer. During the last flight, the heat in the area became intense enough to melt the epoxy holding the oil tank level sensor in place, causing the oil leak. At some time, a contained fire started, melting the wire insulation and damaging the air filter for the engine's cooling air. The high temperature in the area also caused the composite material in the rear engine mount to disintegrate.

A number of details relating to the incident cannot be determined without considerably greater investigation resources, and the AIBN has made a decision not to prioritise this. The outstanding issues include:

- It is improbable that the high temperature was only caused by exhaust heat. The oil spill around the tank was modest and there was no sign of oil having burned in a significant amount. Wankel engines generate a lot of carbon monoxide (CO), which is flammable by itself in the presence of oxygen. A crack in the exhaust silencer can therefore have caused CO to come into contact with oxygen-rich cooling air containing oil vapour, adding extra thermal energy.
- The oil level gauge issued a warning although there was enough oil in the tank. This may be linked to the sensor itself or the associated wires being destroyed by heat.
- The air filter for the engine's internal cooling had melted and suffered a permanent concave deformation of the end wall. This indicates that the cooling fan had sucked air through the filter while the air filter had been hot. In such a situation, it is natural to assume that the cooling air is very hot before reaching the engine, and that the warning for high ICAOut will

be triggered. The AIBN has no explanation for why this warning was not triggered, alternatively not detected by the commander.
- The AIBN has not tried to determine for how long the internal crack in the exhaust silencer had been there, or what caused the cracking.
- The AIBN has not looked into why the engine did not stop in the cooling position, but continued towards full retraction.

A fire or near-fire in an engine installation is a serious matter. It is therefore important to detect possible warning signs in time. Following the incident, the manufacturer Alexander Schleicher GmbH & Co Segelflugzeugbau has described signs that indicates a crack in the exhaust silencer. It is hard for a pilot to determine what constitutes normal discolouring of an exhaust system due to age and what constitutes abnormal discolouring. A crack will normally develop gradually, and changes over time can be hard to detect. It will be especially difficult if the aircraft has many users, making it hard to spot a trend. The AIBN therefore believes that both the description of the daily inspection in the flight manual and the maintenance instructions should contain guidelines for detecting abnormal changes near the exhaust silencer. Furthermore, the flight manual should contain information to the effect that an increase in ICAOut, under otherwise similar conditions, may indicate an abnormally high temperature in the area surrounding the air filter.

The AIBN has noted that the aircraft's flight manual has not been revised since first being issued in 2007. The manufacturer has not stated when the first revision can be expected. The AIBN is of the opinion that information which can prevent fires in the engine installation must be communicated to users without unnecessary delay. A safety recommendation is therefore issued on this subject.

SAFETY RECOMMENDATIONS

The Accident Investigation Board Norway makes the following safety recommendation[2]:

Safety recommendation SL No. 2016/01T

Cracks in the exhaust silencer of Alexander Schleicher GmbH & Co Segelflugzeugbau ASK 21 Mi aircraft can cause heat damage and possible fire in the engine compartment. In the opinion of the Accident Investigation Board Norway, this has not been sufficiently covered and emphasised in the aircraft's flight manual, maintenance programme or other official information from the glider manufacturer.

The Accident Investigation Board Norway therefore recommends that Alexander Schleicher GmbH & Co Segelflugzeugbau makes public relevant information so that users of ASK 21 Mi can be advised on how to detect leaks in the exhaust silencer at an early stage.

The Accident Investigation Board Norway

Lillestrøm, 23 February 2016

[2] Provisions concerning safety recommendations and their follow-up are provided in Regulation (EU) 996/2010 Art. 17-18.