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Swiss Transportation Safety Investigation Board STSB

Final Report No. 2308

by the Swiss Transportation Safety Investigation Board STSB

concerning the accident involving the
Fairchild 24R46A “Argus III” aircraft,
registration HB-ERO,

on 23 August 2016

Oberhöhnwilen, municipality of
Ermatingen/TG

Ursache

Der Unfall ist auf einen Motorausfall im Reiseflug mit anschliessender Notlandung zurückzuführen, weil eine Kurbelwellenwange infolge eines Ermüdungsbruchs versagte und der Motor dadurch blockierte.

General information on this report

This report contains the Swiss Transportation Safety Investigation Board's (STSB) conclusions on the circumstances and causes of the accident which is the subject of the investigation.

In accordance with Art 3.1 of the 10th edition, applicable from 18 November 2010, of Annex 13 to the Convention on International Civil Aviation of 7 December 1944 and Article 24 of the Federal Air Navigation Act, the sole purpose of the investigation of an aircraft accident or serious incident is to prevent accidents or serious incidents. The legal assessment of accident/incident causes and circumstances is expressly no concern of the investigation. It is therefore not the purpose of this investigation to determine blame or clarify questions of liability.

If this report is used for purposes other than accident/incident prevention, due consideration shall be given to this circumstance.

The definitive version of this report is the original in the German language.

All information, unless otherwise indicated, relates to the time of the accident.

All times in this report, unless otherwise indicated, are stated in local time (LT). At the time of the accident, Central European Summer Time (CEST) applied as local time in Switzerland. The relation between LT, CEST and coordinated universal time (UTC) is:
 $LT = CEST = UTC + 2 \text{ hours}$.

Final report

Aircraft type	24R46A (UC-61K) “Argus III”		HB-ERO	
Operator	Verein Fairchild Club Vorbruggenweg 3, 8422 Pfungen, Switzerland			
Owner	Verein Fairchild Club Vorbruggenweg 3, 8422 Pfungen, Switzerland			
Pilot	Swiss citizen, born 1944			
Licence	Private pilot licence aeroplane (PPL (A)) according to the European Aviation Safety Agency (EASA), issued by the Federal Office of Civil Aviation (FOCA)			
Flying hours	Total	757 hours	During the last 90 days	15 hours
	on the type involved in the accident	93 hours	During the last 90 days	15 hours
Location	Oberhöhnwilen, municipality of Ermatingen/TG			
Coordinates	723 973 / 279 028 (Swiss Grid)	Elevation	approximately 530 m AMSL	
Date and time	23 August 2016, 15:47			
Type of operation	Visual flight rules (VFR), private			
Flight phase	Cruising			
Type of accident	Engine failure with subsequent forced landing			
Injuries to persons				
Injuries	Crew members	Passengers	Total number of occupants	Other
Fatal	0	0	0	0
Serious	0	0	0	0
Minor	0	0	0	0
None	1	1	2	Not applicable
Total	1	1	2	0
Damage to aircraft	Engine badly damaged			
Other damage	None			

1 Factual information

1.1 Pre-flight history and history of the flight

1.1.1 General information

The radar recordings and the statements of the pilot and passenger were used for the following description of the pre-flight history and the history of the flight.

This was a private flight under visual flight rules (VFR).

1.1.2 Pre-flight history and history of the flight

On the afternoon of 23 August 2016, two members of the Verein Fairchild Club owners' association met at approximately 15:00 on Lommis aerodrome (LSZT) for a sightseeing flight. Both had many years' flying experience and a large number of flying hours on the 24R46A (UC - 61K) aircraft registered as HB-ERO, also known by the commercial name "Argus III".

After the usual flight preparations (briefing) a pre-flight check was carried out on the aircraft; everything was in order, including the engine oil level. Then one pilot took the front left seat and the other took the front right passenger seat as a passenger.

Shortly afterwards, HB-ERO took off at 15:15 from runway 06 and followed the right downwind toward Matzingen. The flight continued over the municipalities of Stein am Rhein, Mammern, Steckborn and Ermatingen, in order to return from there to Lommis (cf. Figure 1).

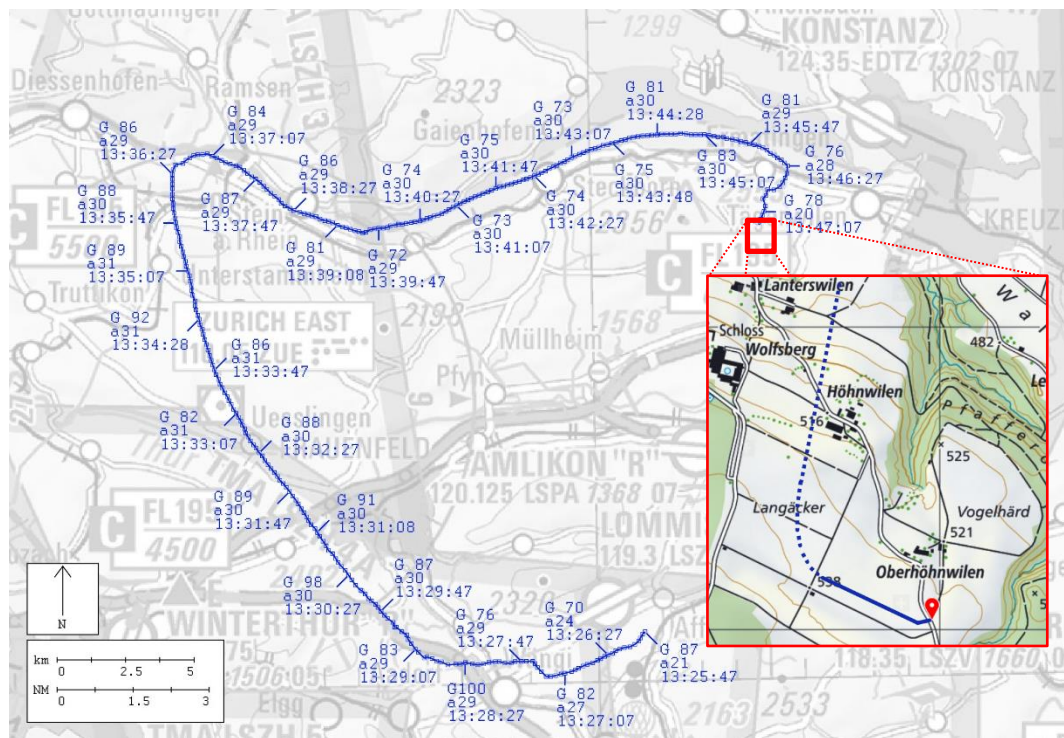


Figure 1: Flight path of HB-ERO after take-off from runway 06 in Lommis (LSZT) according to radar recordings until the forced landing near Oberhöhnwilen, municipality of Ermatingen/TG (red rectangle with approximate flight path and landing direction) on obstacle-free farmland with information on ground speed (G) in knots, altitude (A) in hundreds of feet QNH and time in UTC, base map reproduced with the consent of Swisstopo, the Federal Office of Topography (JA150149).

According to the pilot, while cruising he set an engine speed of approximately 2000 RPM¹. He read off an oil temperature of 180 °F, which was approximately 10 to 20 °F above the usual value when cruising. When south of Ermatingen, at approximately 15:46, at an altitude of approximately 3000 ft QNH, the aircraft's engine began to rumble. Moments later there was a bang and the engine seized.

The pilot immediately searched for a suitable forced landing site and decided to land HB-ERO on uncultivated farmland near Weiler Oberhöhnwilen in a south-easterly direction. The two occupants were uninjured during the landing and the aircraft was not further damaged.

There was no other damage.



Figure 2: Aircraft HB-ERO after the forced landing near Oberhöhnwilen

1.2 Meteorological information

1.2.1 General weather situation

An area of pronounced high pressure extended from Denmark to Austria. At the same time a ridge extended from south-west Europe to Germany and reinforced the influence of the high pressure zone.

1.2.2 Weather at the time and location of the accident

The weather was sunny. There was a light wind of approximately 5 knots from the east north-east. Visibility was over 70 km.

Weather/cloud	1/8 CI at 30 000 ft AMSL ²
Visibility	Over 70 km
Wind	075 degrees, approx. 5 kt
Temperature/dew point	25 °C / 14 °C
Atmospheric pressure (QNH)	1026 hPa, (pressure reduced to sea level, calculated using the values of the ICAO ³ standard atmosphere)
Hazards	None

¹ RPM: revolutions per minute

² AMSL: above mean sea level

³ ICAO: International Civil Aviation Organisation

1.2.3	Astronomical information	
	Lighting conditions	Daylight
	Position of the sun	Azimuth 230 degrees Elevation 43 degrees
1.3	Aircraft information	
1.3.1	General information	
	Registration	HB-ERO
	Aircraft type	24R46A (UC-61K) "Argus III"
	Characteristics	Single-engine, four-seater aircraft, with piston engine and fixed propeller, constructed as a high-wing aircraft with steel tube frame and fabric covering, fixed landing gear in tailwheel configuration.
	Manufacturer	Fairchild Engine and Airplane Corporation, Hagerstown, Maryland, USA
	Year of manufacture	1943
	Owner	Verein Fairchild Club Vorbruggenweg 3, 8422 Pfungen, Switzerland
	Operator	Verein Fairchild Club Vorbruggenweg 3, 8422 Pfungen, Switzerland
	Engine	Ranger Aircraft Engine Division, 6-440-C5, Ranger 200 CV Air-cooled 6-cylinder in-line engine, 200 PS (cf. section 1.3.2)
	Hours of operation	Airframe 3976 hours TSN ⁴ Engine 3164 hours TSN 447:30 hours TSO ⁵
	Mass and centre of gravity	Both mass and centre of gravity were within the permissible limits according to the aircraft flight manual (AFM).
	Maintenance	The last 100-hour annual check was carried out on 3 May 2016 at 3948:18 operating hours (airframe) and 3136:30 operating hours (engine) (cf. section 1.3.2).
	Fuel grade at the time of the accident	AVGAS 100LL. The fuel corresponded to the required specifications apart from the lead content; at 520 mg/L which was below the permitted minimum of 530 mg/L. However, this had no influence on the cause of the accident.
	Licence	Private
	Category	VFR by day

⁴ TSN: time since new

⁵ TSO: time since overhaul

1.3.2 Information on the engine

The 200 PS engine of HB-ERO which dates from 1943 has the internal company designation 6-440-C5. The US military designated the engine as a Ranger L-440. It existed in different performance classes: 175 PS, 180 PS, 190 PS and a 200 PS variant. The 6 cylinders of the engine are air-cooled and arranged suspended in-line.

The engines were mainly built for the family of Fairchild training aircraft in the mid 1930s, at the Ranger Aircraft Engine Division, a subsidiary of the Fairchild Aircraft and Engine Corporation. During World War 2 more than 15 000 units were manufactured and fitted to more than 6000 trainer aircraft of the Fairchild PT-19 and PT-26 types.

In 2005 a total overhaul of the engine was performed at 2716:39 hours TSN (656:31 hours TSO). In 2013 the engine was partly overhauled at 3029:58 hours TSN (313:19 hours TSO).

The last maintenance work was carried out on the occasion of the 100-hour annual check from 1-3 May 2016 at 3136:30 TSN engine. In the process, the cause of the inside of the rear fuselage being badly contaminated with oil was eliminated by the following measures:

- Oil reservoir nuts replaced.
- Oil cooler repaired, examined and drained.

The left magneto coupling ring was also subsequently replaced. The compression values of the individual cylinders were satisfactory.

In the months following the 100-hour annual check it is remarkable that according to the logbook, after each flight, even of short duration, the engine was topped up with several litres of oil.

1.4 Findings at the site of the accident

The following findings were made at the site of the accident:

- The aircraft did not exhibit any signs of external damage and the controls functioned perfectly.
- The flaps were retracted.
- All electrical switches and the magnetos were switched off and the fuel cocks were closed.
- Engine oil was dripping out at the transition from the lower engine cowling to the airframe. The right and lower engine cowling as well as the front half of the underside of the aircraft were heavily contaminated with oil.
- After disassembly of the lateral engine covers, it was found that the crankcase was fractured towards the rear of the engine.
- Various components were found on the lower engine cover, among other things crankshaft counterweights and fragments of the engine housing.
- The accessory section as well as the two magnetos had become separated from the engine (cf. Figure 3).

1.5 Damage to the engine

1.5.1 General

In the course of further investigations, the following findings were made on the engine:

- The rearmost cylinder no. 1, viewed in the direction of flight, as well as its piston and the associated part of the housing, were destroyed; the crankshaft was broken and the camshaft was bent.
- The piston rod was bent through approximately 160 degrees.
- The crankcase was destroyed as far as cylinder no. 3.
- Except for the front right engine mount, all mounts were separated from the engine housing.

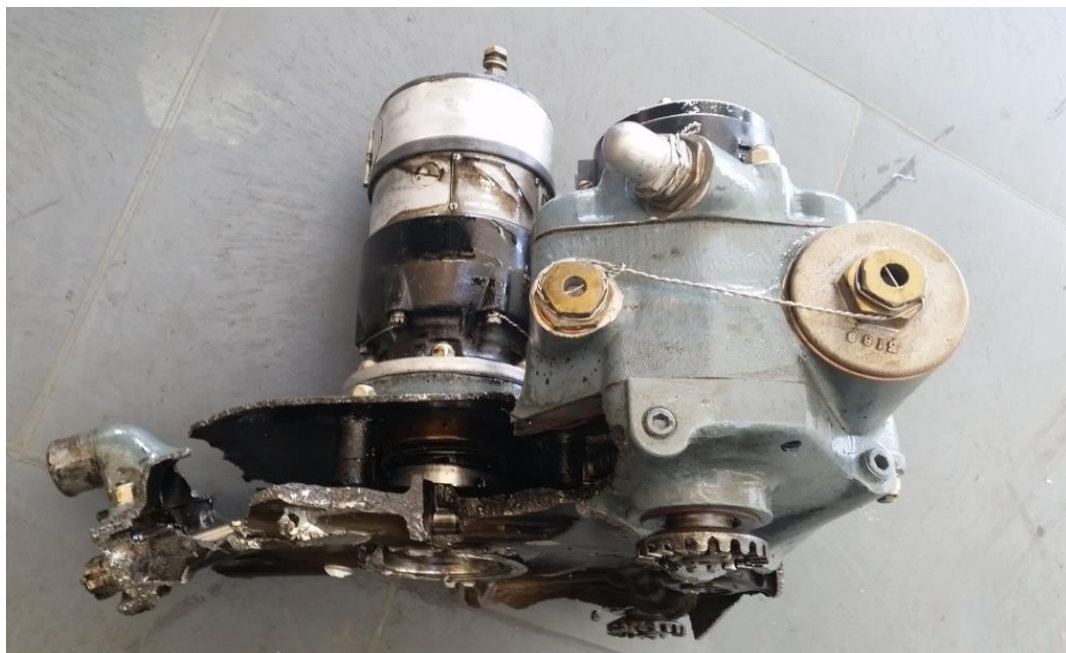


Figure 3: The accessory section and the two magnetos were separated from the engine of HB-ERO.



Figure 4: The components of cylinder no. 1 (marked in red), the rearmost cylinder viewed in the direction of flight, were destroyed.

1.5.2 Metallurgical investigations

For further clarification, among other things the fracture surfaces of the following parts of the engine were examined metallographically (cf. Figure 5)

- Crankpin no. 1 with piston rod and broken-off crankshaft webs (A);
- Separated section of the crankshaft (B).

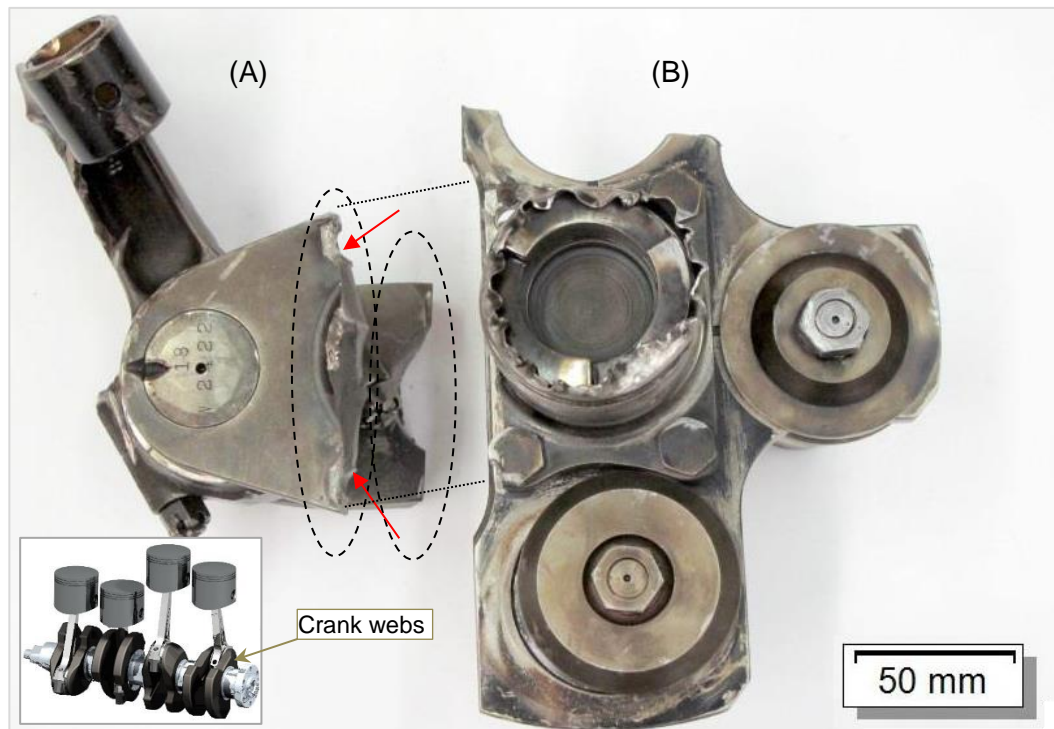


Figure 5: Part (A) with the two broken-off crankshaft webs (marked by broken lines) and part (B) of the engine of HB-ERO for metallographic investigation of the fracture surfaces (red arrows)

In terms of the material, no characteristics relating to the cause of the fracture were found. Owing to the secondary damage caused by the reciprocal friction of the fracture surfaces, the fractures could no longer be clearly interpreted microfractographically. Nevertheless, there were indications of various fatigue failure zones (cf. Figure 6 Zones A, B, C, D and G are fatigue fracture surfaces which exhibit clear striations. It was not possible to analyse fracture zone H due to mechanical damage.

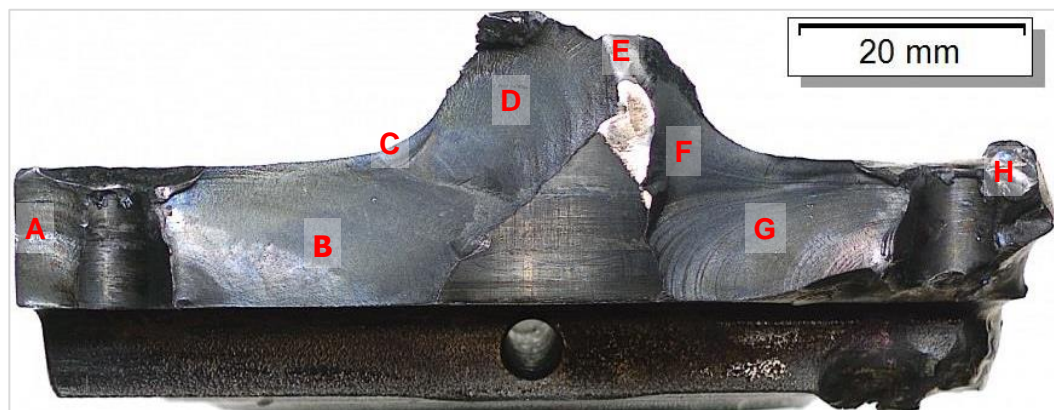


Figure 6: Fracture surface of the crankshaft web with the fatigue fracture surfaces in zones A, B, C, D and G (from left to right); it was not possible to analyse fracture zone H.

2 Analysis

2.1 Technical aspects

The fatigue fractures found by metallographic examination (cf. section 1.5.2) were initiated over a fairly long time at different points on a crankshaft web of rear cylinder no. 1. The residual fracture surface was small, which in normal operation suggests a low load on the crankshaft web.

It cannot therefore be completely excluded that the cracking at the crankshaft occurred since the engine was first put into service. It can be assumed with a high degree of probability that a crack was present at the time of the last total overhaul of the engine in 2005 at 2716:39 hours TSN. Such cracks usually are detected on the occasion of a crack test as part of a total overhaul.

This pre-existing weakening was the cause of the sudden fracture of the crankshaft webs of the rearmost cylinder, viewed in the direction of flight, whilst cruising with a normal load on the engine, leading to the engine immediately seizing up and to serious damage to the engine. The slightly increased oil temperature when cruising, as well as the engine's increased oil consumption, do not provide a plausible explanation in respect of an existing connection with the pre-existing damage at the crankshaft.

Otherwise, there were no indications of any other pre-existing technical defects which might have influenced the accident.

2.2 Human and operational aspects

For the two occupants, these fatigue fractures and the resulting impending engine failure were not discernible.

When the pilot realised that the engine had seized, he decided immediately on a forced landing. He selected an obstacle-free field and was able to land the aircraft on it without endangering the occupants or third parties. This prudent conduct defused the dangerous situation which had arisen from the engine failure and prevented further damage.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- The aircraft was licensed for VFR traffic.
- At the time of the accident both the mass and centre of gravity of the aircraft were within the permissible limits according to the AFM.
- On the occasion of the last total overhaul of the engine in 2005 at 2716:39 hours TSN, the crack on the crankshaft web remained undetected.
- The last 100-hour annual check was carried out on 3 May 2016 at 3136:30 operating hours (engine).
- Metallographic investigations revealed that fatigue fractures had been initiated over a fairly long period at various points on a crankshaft web of the rearmost cylinder and that the extent of the fatigue fracture was small.

3.1.2 Pilot

- The pilot was in possession of the licences required for the flight.
- There are no indications of the pilot suffering any health problems during the flight involved in the accident.

3.1.3 Flight history

- After the usual preparations and pre-flight checks, the Fairchild 24R46A aircraft, registration HB-ERO, took off with two occupants from runway 06 in Lommis (LSZT) on a sightseeing flight.
- After a flight of approximately half an hour, when over the localities of Stein am Rhein, Mammern and Steckborn, HB-ERO was north of Ermatingen at an altitude of approximately 3000 ft QNH when the engine suddenly started to rumble and seized up moments later.
- The pilot then made a forced landing on uncultivated farmland near Weiler Oberhöhnwilen.
- Neither of the occupants was injured.
- The aircraft did not suffer any further damage; there was no other damage.

3.1.4 General conditions

- The weather had no effect on the origin of the accident.

3.2 Causes

The accident is attributable to an engine failure whilst cruising with a subsequent forced landing, because a crankshaft web failed as a result of a fatigue fracture which caused the engine to seize.

4 Safety recommendations, safety advices and measures taken since the accident**4.1 Safety recommendations**

None

4.2 Safety advices

None

4.3 Measures taken since the accident

None

This final report was approved by the Board of the Swiss Transportation Safety Investigation Board STSB (Art. 10 lit. h of the Ordinance on the Safety Investigation of Transportation Incidents of 17 December 2014).

Bern, 13 July 2017

Swiss Transportation Safety Investigation Board