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Swiss Transportation Safety Investigation Board STSB

Final report No. 2408 by the Swiss Transportation Safety Investigation Board STSB

concerning the serious incident involving the aircraft Rockwell 112 "Commander", N559SG,

on 18 September 2021

about 1 km north-northeast of Reichenburg (SZ)

Swiss Transportation Safety Investigation Board STSB
3003 Bern
Tel. +41 58 466 33 00, Fax +41 58 466 33 01
info@sust.admin.ch
www.stsb.admin.ch

General information on this report

In accordance with

Article 3.1 of the 12th edition of Annex 13, effective from 5 November 2020, to the Convention on International Civil Aviation of 7 December 1944, which entered into force in Switzerland on 4 April 1947, as at 18 June 2019 (SR *0.748.0*);

Article 24 of the Federal Act of 21 December 1948 on Aviation, as at 1 September 2023 (AviA; SR *748.0*);

Article 1 paragraph 1 Regulation (EU) 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC, which entered into force in Switzerland on 1 February 2012 in accordance with a decision by the joint committee of the Swiss Confederation and the European Union (EU) and based on the Air Transport Agreement of 21 June 1999 between Switzerland and the EU;

and Article 2 paragraph 1 of the Ordinance of 17 December 2014 on the Safety Investigation of Transportation Incidents, as at 1 September 2023 (OSITI; SR *742.161*);

the sole purpose of an investigation into an aircraft accident or serious incident is to prevent further accidents or serious incidents from occurring. It is therefore expressly not the purpose of this safety investigation and report to establish blame or to determine liability.

Should this report be used for purposes other than those of accident prevention, this statement should be given due consideration.

The German version of this report is the original and therefore prevails for all purposes.

Unless otherwise indicated, all details given refer to the time the serious incident occurred.

Unless otherwise indicated, all times in this report are stated in local time (LT) for Switzerland. This was Central European Summer Time (CEST) at the time the serious incident occurred. The relationship between LT, CEST and coordinated universal time (UTC) is:
LT = CEST = UTC + 2 hours.

Executive summary

Aircraft type	Rockwell 112 “Commander”			N559SG
Keeper	Private			
Owner	Private			
Pilot	Swiss citizen, born 1957			
Licence	Private Pilot Licence Aeroplane (PPL(A)) according the standards of the European Union Aviation Safety Agency (EASA), issued by the Federal Office of Civil Aviation (FOCA)			
Flying hours	**Total**	2,186:55 hrs	**During the last 90 days**	19:30 hrs
	on type	approx. 860 hrs	**During the last 90 days**	9:35 hrs
Location	About 1 km north-northeast of Reichenburg (SZ)			
Coordinates	226 333 / 717 541 (*Swiss Grid* 1903)		**Altitude** 410 m AMSL[1]	
Date and time	18 September 2021, 15:50 local time (LT)			
Type of operation	Private			
Flight rules	Visual Flight Rules (VFR)			
Point of departure	Bad Ragaz airfield (LSZE)			
Destination	Bad Ragaz airfield (LSZE)			
Flight phase	Cruise flight			
Type of serious incident	Precautionary off-airfield landing due to engine problems			

Injuries to persons

Injuries	Crew members	Passengers	Total number of occupants	Third parties
Fatal	0	0	0	0
Serious	0	0	0	0
Minor	0	0	0	0
None	1	0	1	Not applicable
Total	1	0	1	0

Damage to aircraft	Slightly damaged (engine)
Damage to third parties	None

[1] AMSL: above mean sea level

1 Factual information

1.1 Flight events

1.1.1 General information

The following description of the flight is based on the pilot's statements and a radar recording. It was a private flight under visual flight rules. Good visual flying weather conditions prevailed.

1.1.2 Course of the serious incident

At approximately 15:25 on 18 September 2021, the pilot, who was alone onboard, took off from runway 30 of Bad Ragaz airfield (LSZE) in the aircraft Rockwell 112 “Commander”, registered as N559SG. He flew along the Walensee towards Weesen. Shortly after Weesen and at a pressure altitude of around 4400 ft QNH[2], the pilot suddenly became aware of vibrations (cf. figure 1). He checked the engine instruments, and seeing nothing untoward, continued the flight.

The pilot moved the mixture control forward to 'full rich' and switched on the electric fuel pump. He noticed that the engine continued to provide power but was not running smoothly. He reduced the engine power somewhat. Fearing that the situation could get worse, he looked out for a suitable place to land. He decided to make a precautionary landing (cf. chapter 1.5).

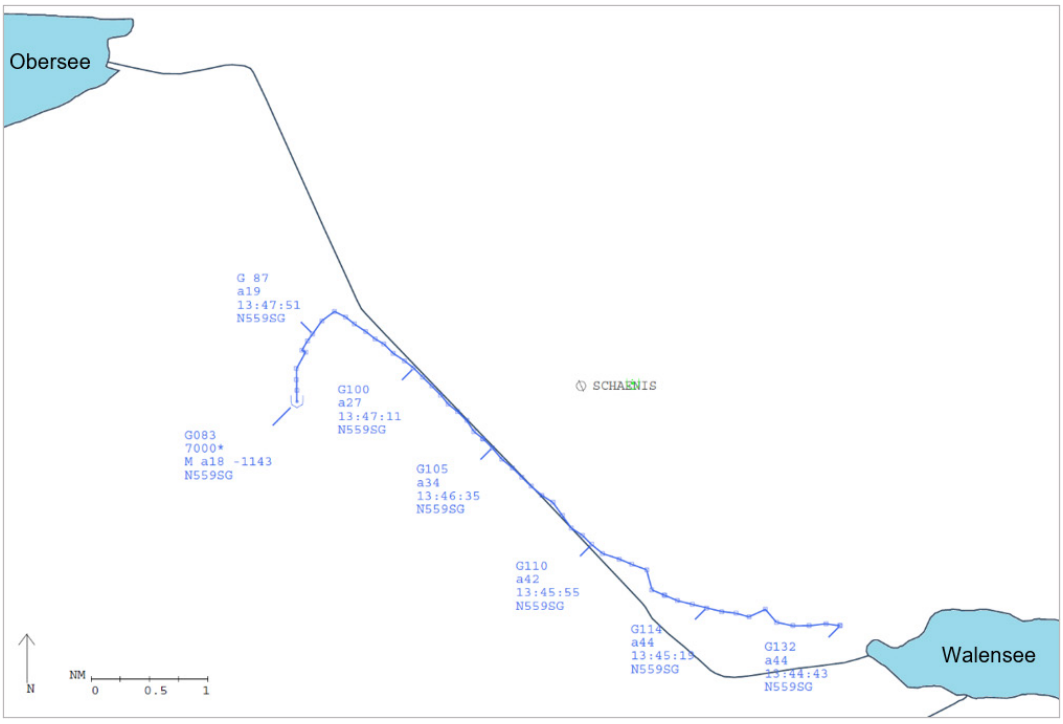

Figure 1: Radar recording of the N559SG's flight path indicating ground speed (G) in knots, pressure altitude (a) in hundreds of feet and time in UTC, from the Walensee to a position shortly before the aircraft landed at a pressure altitude of 1800 ft QNH. In the centre of the picture Schänis airfield (LSZX) can be seen; this is at 1365 ft AMSL and has a concrete runway 520 m long.

The pilot chose to land on a meadow in the Linth plain which he had spotted to his left. He reduced the engine power, configured the aircraft for landing and touched down at about 15:50. No damage was caused during landing. After landing, the pilot noticed that the underside of the aircraft fuselage was heavily smeared with

[2] QNH: pressure reduced to sea level based on the values of the standard atmosphere

oil along its entire length and that engine oil was dripping from the lower engine cowling.

1.2 Aircraft information

1.2.1 General

Registration mark	N559SG
Aircraft type	Rockwell 112 “Commander”
Design	Single-engine, four-seater touring aircraft. Cantilever low-wing monoplane of all-metal construction with retractable undercarriage in nose wheel arrangement.
Manufacturer	Rockwell International, Commander Aircraft Division (USA)
Year of manufacture	1975
Engine	Air-cooled piston engine with four cylinders in boxer configuration and a rated power of 200 hp (149 kW) at 2700 rpm. Manufacturer: Lycoming Engines (USA) Engine type: IO-360-C1D6 Year of manufacture: 1975
Engine hours	Airframe 2,059:40 hrs (TSN[3]) Engine 2,059:40 hrs (TSN)
Registration certificate	Issued by the FAA[4] on 31 March 2021, valid until 31 March 2024
Certificate of Airworthiness	Issued by the FAA on 23 April 2015

1.2.2 Aircraft history

The Rockwell 112 had been registered in the Swiss Aircraft Register as HB-NCK since 1976. As of 2007, the pilot was both the owner and operator of the aircraft. In 2014, he applied to the Federal Office of Civil Aviation (FOCA) to exceed the number of engine hours recommended by the manufacturer (*time between overhaul,* TBO) for the Lycoming IO-360 engine, which had been installed in the aircraft since it was new. In a letter dated 12 December 2014, the FOCA turned down this request as follows:

> *"As your engine has been installed for 39 years[5] and it has not been overhauled or disassembled for inspection during this time, we regret that we must reject your request."*

On 13 March 2015, the aircraft was removed from the Swiss Aircraft Register and shortly thereafter was recorded in the US register as N559SG. On the day of the incident, the engine was 46 years old and had 2,059 engine hours, compared to the manufacturer's recommended[6] 12 years or 2,000 hours. During this time, the engine had undergone neither a major overhaul nor disassembly.

[3] TSN: Time since new

[4] FAA: Federal Aviation Administration (FAA)

[5] The annexes to FOCA service bulletin TM 02.020-35 state that an engine must be overhauled after a maximum of 36 years, depending on aircraft use.

[6] The engine manufacturer's Service Instruction No. 1009 lists the recommended operating times (in calendar time and engine hours) until a major overhaul of the various engine types should be carried out.

1.2.3 Maintenance work

On 25 May 2001, more than 20 years before the serious incident took place, a 100-hour inspection was carried out at 1,089:40 engine hours to check the engine's condition. The following was recorded in the maintenance log book: *"This is to certify that the engine has been inspected in accordance with TM-W 15.010-91 and has no corrosion or ageing damage affecting its operation."* After that, no further special inspections to extend TBO were recorded. The last maintenance work prior to the serious incident was recorded in a 100 hr/annual inspection on 25 March 2021 at 2,037 engine hours.

1.3 Findings on the engine

On cylinder #1, the exhaust flange had separated from the exhaust pipe and a large segment of it was cracked; the intake hose was loose and damaged on both sides. The damage had most likely been caused over some time. Furthermore, a stud bolt was broken and the engine case was cracked around the cylinder (cf. figure 2).

Figure 2: Cylinder #1 with cracked engine case (yellow arrows).

1.4 Information from the authorities and manufacturers

1.4.1 Information from regulating authorities

The FOCA stated that it had no means of action in the case of a US-registered aircraft stationed in Switzerland; the FAA's system differs from that of EASA, and FAR Part 91[7] regulations are considerably less stringent than the Swiss regulations. Although the FOCA has no direct influence, it maintains close contact with the FAA and can intervene with the FAA representative in Brussels.

The FAA did not respond when asked how it dealt with cases in which the engine manufacturer's recommended TBO was exceeded.

1.4.2 Information from the engine manufacturer Lycoming Engines

The engine manufacturer Lycoming Engines stated that an engine's operating times until a major overhaul as set out in Service Instruction No. 1009 are recommendations only. It was not able to declare a major engine overhaul compulsory after the expiry of the TBO.

1.5 Information on the precautionary landing procedure

A precautionary landing is an established procedure and is part of pilot training.[8] It can take place on or off an airfield. The decision to make a precautionary landing is made when this option is considered safer than continuing the flight.

[7] FAR Part 91: Federal Aviation Regulations Part 91, regulations of the Federal Aviation Authority (FAA) describing general operating and flight rules.

[8] Cf. SPHAIR Principles and Procedures for Basic Flight Training, Chapter 17, www.sphair.ch, based on the provisions of EASA (Easy Access Rules for Flight Crew Licensing (Part-FCL), Subpart C – PPL *«Syllabus of flight instruction»*)

2 Analysis

2.1 Technical aspects

The likelihood of engine problems occurring due to material fatigue, corrosion or wear increases as an engine ages. The engine manufacturer therefore recommends a major overhaul after 12 years. However, depending on usage and place of use, an engine may still be in good condition beyond this point. In order to determine this, special inspections are necessary.

Nonetheless, since the entire engine interior cannot be checked in a special inspection and material fatigue in particular can go unnoticed, a general overhaul must be carried out at some point. The limit of 36 years set by the Federal Office of Civil Aviation (FOCA) takes this circumstance into account. Until the FOCA's negative decision, however, the engine was operated for 39 years, the last 20 of which were without a special inspection.

By changing the country of registration, it was possible to circumvent FOCA's general overhaul requirement. Furthermore, no special inspection or comparable work was carried out after reregistration in the US. The engine had been in operation for 46 years at the time of the incident.

All things considered, it seems clear that the fracture in the engine case was the result of material fatigue.

2.2 Operational aspects

The pilot noticed unusual engine vibrations. He assumed that the condition of the engine might rapidly deteriorate further and therefore decided to make a precautionary landing. This decision showed an awareness of safety and was appropriate to the situation. However, by landing off-airfield, he ran the risk of an accident that could have been avoided by landing at an airfield in the same time frame.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- A large part of the engine case at cylinder #1 had broken off.
- The last maintenance work to be carried out was in an annual inspection recorded on 25 March 2021 at 2,037 engine hours.
- The engine had 2,059:40 hours at the time of the serious incident and had been in operation for 46 years. During the entire period of operation, the engine neither underwent a major overhaul nor was it disassembled for inspection.
- The only special inspection it underwent was for a twelve-year extension of the TBO, certified in 2001.

3.1.2 Course of the serious incident

- The pilot took off from runway 30 of Bad Ragaz airfield.
- After about 20 minutes of flight time, the pilot noticed that the engine was not running at all smoothly.
- The pilot performed a precautionary landing off-airfield.

3.1.3 Conditions

- The FOCA had made a major engine overhaul a condition for continued operation of the aircraft. Changing the country of registration made it possible to circumvent this requirement.

3.2 Causes

To achieve its purpose of prevention, a transportation safety investigation board must address the risks and dangers involved in the investigated incident and which should be avoided in future. The terms and wording used below are only to be interpreted in terms of prevention. The establishment of the causes and contributing factors does not attribute blame in any way or determine liability under administrative, civil or criminal law.

The serious incident, in which the pilot performed a precautionary landing off-airfield because the engine was not running smoothly, is due to age-related engine damage.

4 Safety recommendations, safety advices and measures taken since the serious incident

4.1 Safety recommendations

None

4.2 Safety advices

None

4.3 Measures taken since the serious incident

None

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

Bern, 19 September 2023 Swiss Transportation Safety Investigation Board