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Swiss Transportation Safety Investigation Board STSB

Final Report No. 2384

by the Swiss Transportation Safety Investigation Board STSB

concerning the serious incident involving
the aircraft PA-28-181, LX-AVA,

on 19 July 2020

approximately 2 km west of the airport
St. Gallen-Altenrhein (LSZR)

General information on this report

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

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 and Article 24 of the Federal Act on Civil Aviation (CAA, SR 748.0) of 21 December 1948 (as amended on 1 January 2022), 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 prevention, due consideration shall be given to this circumstance.

The definitive version of this report is the original report in German and therefore binding.

All information, unless otherwise indicated, relate to the time of the serious incident.

In this report, the masculine form is used for all natural persons irrespective of their sex, for reasons of protection of personality.

All times in this report, unless otherwise indicated, are stated in Local Time (LT), valid for the territory of Switzerland, which correspond to Central European Time (CET) at the time of the serious incident. The relation between LT, CET and Coordinated Universal Time (UTC) is:

LT = CET = UTC + 2 hours.

Synopsis

Aircraft	PA-28-181	LX-AVA		
Operator	Avia Sport a.s.b.l., Route de Trèves, L-1110 Findel, Luxembourg			
Owner	Avia Sport II, Aéroport du Findel, L-1110 Findel, Luxembourg			
Pilot	Luxembourg national, born 1968			
Licence	Private Pilot Licence Aeroplane PPL(A) according to European Union Aviation Safety Agency, issued by the Luxembourg Civil Aviation Authority (<i>Direction de l'aviation Civile</i> – DAC)			
Flying experience	total	234:20 h	during the last 90 days	9:54 h
	on type	234:20 h	during the last 90 days	9:54 h
Location	Approximately 2 km west of the airport St. Gallen-Altenrhein (LSZR)			
Coordinates	261 580 / 757 560 (<i>Swiss Grid</i> 1903)	altitude	475 m/M	
	N 47° 29' 10" / E 009° 31' 46" (WGS ¹ 84)			
Date and time	19 July 2020, 18:10 hrs			
Type of operation	Private			
Flight rules	Visual Flight Rules (VFR)			
Point of departure	St. Gallen-Altenrhein (LSZR)			
Destination	Luxembourg (ELLX)			
Flight phase	Take-off and climb			
Type of serious incident	Loss of power			
Injuries to persons				
Injuries	Crew	Passengers	Total of occupants	Third persons
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	Not damaged			
Other damage	None			

¹ WGS: World Geodetic System, The WGS 84 standard was adopted for aviation by decision of the International Civil Aviation Organization (ICAO) in 1989.

1 Factual information

1.1 Flight preparations and history of flight

1.1.1 General

The description of the event is based on the information provided by the pilot and the passenger, who also had a valid license and class rating for single engine piston aircraft, as well as the radar and voice radio recordings.

1.1.2 Pre-flight history

The flight during which the serious incident occurred was part of a day trip from Luxembourg (ELLX) to St. Gallen-Altenrhein (LSZR). The outbound flight of the four-seat single engine aircraft Piper PA-28-181, registered as LX-AVA, was uneventful and the aircraft landed at the day's destination at approximately 16:15 hrs.

After a stopover of about two hours, the pilot and the passenger started the return flight; the latter took over the radiotelephony with the air traffic control.

1.1.3 History of flight

After the preflight check, the pilot started the engine and performed the run up without any abnormalities. Also during the take-off run on runway 28, the two occupants did not detect any abnormalities based on the on-board instrument readings. The LX-AVA took off at 18:25 hrs at around 60 KIAS². After accelerating to 85 KIAS and about one minute after takeoff, at an altitude of 1550 ft QNH³, about 250 ft above the lake, a noticeable loss of power associated with engine stuttering occurred. Although the pilot immediately leveled off the aircraft, the speed rapidly decreased to 68 KIAS (see figure 1).



Figure 1: Flight path of LX-AVA (red line) after take-off from St. Gallen-Altenrhein (LSZR) on runway 28, followed by a reversal turn and subsequent landing on runway 10. Source of map: Federal Office of Topography.

The pilot then operated the fuel selector and checked the correct position of the ignition key, thrust lever and mixture lever and saw that the electric fuel pump switch was in the "ON" position and that the carburetor heat control was in the "OFF" position. The displays of the engine instruments were in the green zone and none of the circuit breakers had tripped. The engine stuttering persisted, so the

² KIAS: Knots Indicated Air Speed

³ QNH: pressure reduced to sea level based on the values of ICAO standard atmosphere

pilot initiated a reversal turn to the right, while at 18:25:55 hrs the passenger advised in scarce words over the radio that the engine was stuttering and that they were returning to the airport. The air traffic controller then acknowledged the seriousness of the situation and responded that runway 10 would be available to them for a priority landing. The passenger subsequently stated that they would have to land and declared emergency. The aerodrome traffic controller then cleared the aircraft for landing, and LX-AVA landed on the runway at 18:27:47 hrs. The aircraft did not suffer any damage. None of the occupants were injured.

1.2 Aircraft information

The Piper PA-28-181 is a single-engine, low wing all metal four-seater aircraft. It has a fixed tricycle landing gear. The aircraft is equipped with a four-cylinder, air-cooled, four-stroke boxer Lycoming O-360-A4M engine delivering a take-off power of 180 hp at 2700 RPM at sea level.

1.3 Meteorological information

A shallow ground high and a ridge aloft determined the weather in the Alpine region. The weather was sunny and there was a light wind of 5 kt from 280 degrees at the time of landing.

1.4 Technical Findings

The last maintenance work on LX-AVA took place on 17 July 2020 at 6798:36 airframe operating hours, that is about 1500 h since the last major engine overhaul, which took place as part of a 100-hour/annual inspection. The compression check (pressure loss measurement) of all cylinders carried out at an intake air pressure of 80 PSI resulted in the following values (see also chapter "Maintenance Information").

Cylinder N° 1	Cylinder N° 2	Cylinder N° 3	Cylinder N° 4
78 PSI	76 PSI	70 PSI	78 PSI

Table 1: Pressure loss measurement of the cylinders from 17 July 2020

LX-AVA totalised 6801:36 hours of operation at the time of landing after the incident.

The inspection carried out on the aircraft on 30 July 2020 revealed that the compression on the No. 3 cylinder was very low. The piston and its associated piston rings showed no damage. The usual burn residues were visible on the intake and exhaust valves of cylinder No. 3 (cf. figure 2 on the following page).

After the installation of a new cylinder as well as new valves, piston and piston rings, the engine then delivered the required power during the test run.



Figure 2: Combustion residues on the intake and exhaust valves of cylinder no. 3.

1.5 Maintenance Information

While cylinder compression tests are not required by the Lycoming Operator's Manual, the Piper Maintenance Manual recommends a compression check every 100 hours. Furthermore, in Service Instruction No. 1191A, the engine manufacturer recommends that a cylinder compression test be performed in the event of a loss of power, increasing oil consumption or any other unexplainable abnormal behaviour of the engine. The decision to carry out such instruction rests with the aircraft operator or the Continuing Airworthiness Management Organisation (CAMO).

Service Instruction No. 1191A states the following:

«3. Interpretation of the results of the test is highly dependent on the skill and judicious opinion of the tester; however, the following observations cover the principle factors to be noted:

- a. Pressure readings for all cylinders should be nearly equal; a difference of 5 PSI is satisfactory; a difference of 10 to 15 PSI indicates an investigation should be made.*

NOTE

Unless the pressure difference exceeds 15 PSI the investigation should not necessarily mean removal of the cylinder; often a valve will reseat itself and result in acceptable compression during a later check which should be made within the next 10 hours of operation.

- b. If the pressure reading for all cylinders is equal and above 70 PSI; the engine is satisfactory; less than 65 PSI indicates wear has occurred and subsequent compression checks should be made at 100-hour intervals to determine rate and amount of wear. If the pressure reading is below 60 PSI or if the wear rate increases rapidly, as indicated by appreciable decrease in cylinder pressure, removal and overhaul of the cylinders should be considered. »*

2 Analysis

2.1 Technical aspects

The loss of compression on cylinder no. 3. was due to a leaking intake or exhaust valve. This is mainly caused by combustion residues such as carbon particles or lead from the use of aviation gasoline (AVGAS), which stick between the valve surface and the valve seat and thus can prevent the valves from closing completely. In exceptional cases, burnt or warped valves can also be responsible for a leak, but this can rather be excluded in the present case.

Leaking valves due to combustion residues between the valve surface and the valve seat can occur suddenly, but mainly in engines with high operating hours, as in the case examined here. The engine of LX-AVA had undergone an annual inspection two days earlier and the compression had been checked on all cylinders. With the exception of cylinder no. 3 with a pressure loss of 10 PSI, the measured values for the other cylinders were good to very good. According to Service Instruction No. 1191A, no immediate measures were necessary for cylinder No. 3.

However, the present case shows that a loss of power can occur only a few operating hours after the last compression check, where the measured values were still within the engine manufacturer's tolerance. Therefore, a timely compression check or a borescope-inspection, for example, seems to make sense. Furthermore, any recordings of engine data can provide conclusions about the condition of the engine.

2.2 Human and operational aspects

After a brief analysis of a possible cause for the partial loss of power during climb, the pilot decided at 250 ft AGL to initiate a reversal turn and, declaring emergency, to land on runway 10 despite a slight tailwind. This plan was well supported by the aerodrome traffic controller; however, reversal turns near the ground carry high risks and not infrequently end in a loss of control.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- The aircraft was certified for flights under Visual Flight Rules (VFR) conditions.
- Both the mass and centre of gravity of the aircraft were within the permissible limits of the Aircraft Flight Manual (AFM) at the time of the serious incident.
- The last maintenance work on LX-AVA took place on 17 July 2020 at 6798:36 airframe operating hours, that is about 1500 h since the last major engine overhaul which took place as part of a 100-hour/annual inspection.
- The compression check (pressure loss measurement) of all cylinders was good to very good except for cylinder no. 3.
- According to Service Instruction No. 1191A, no immediate measures were required for cylinder No. 3.
- The compression check carried out on 30 July 2020 after 6801:36 operating hours showed that the compression of cylinder no. 3 was very low.

3.1.2 Flight Crew

- The pilot held the necessary licences for the flight.
- There is no evidence of health or fatigue-related adverse effects on the pilot during the serious incident.

3.1.3 History of the serious incident

- The four-seat Piper PA-28-181 single engine aircraft, registered LX-AVA, took off from runway 28 of St Gallen-Altenrhein airfield (LSZR) at 18:25 hrs.
- On board were the pilot and a passenger who had a valid license and who took over the radiotelephony communication with air traffic control.
- About one minute after takeoff, at an altitude of 1550 ft QNH, about 250 ft above the lake, a noticeable loss of power occurred, associated with engine stuttering.
- After a brief analysis, the pilot decided to initiate a reversal turn, declared emergency and successfully landed on runway 10.

3.1.4 General conditions

- The weather had no influence on the occurrence of the serious incident.

3.2 Causes

In order to achieve its objective of prevention, a safety investigation authority shall express its opinion on risks and hazards that have been identified during the investigated incident and which should be avoided in the future. In this sense, the terms and formulations used below are to be understood exclusively from the perspective of prevention. The identification of causes and contributory factors does not, therefore, in any way imply assignment of blame or the determination of administrative, civil or criminal liability.

The loss of engine power during climb, resulting in the serious incident, is due to a loss of compression of cylinder No. 3 caused by a leaking intake or exhaust valve.

4 Safety recommendations, safety advice and measures taken since the serious incident**4.1 Safety recommendations**

None

4.2 Safety advice

None

4.3 Measures taken since the serious incident

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, 18 January 2022

Swiss Transportation Safety Investigation Board