LIMITED ACCIDENT INVESTIGATION REPORT

Reference Number	CA18/2/3/10196					
Classification	Accident	**Date**	22 July 2022	**Time**	1256Z	
Type of Operation	Private (Part 94)					
Location						
Place of Departure	Brits Aerodrome (FABS), North West Province		Next Point of Intended Landing	Wonderboom Aerodrome (FAWB), Gauteng Province		
Place of Accident	Open field, approximately 8 nautical miles (nm) north of FAWB					
GPS Co-ordinates	Latitude	25° 33´29. 3" S	Longitude	028° 10´.45.5" E	Elevation	4 058ft
Aircraft Information						
Registration	ZU-FCT					
Make/Model	Sling 2 (Serial Number: 081)					
Damage to Aircraft	Substantial		Total Aircraft Hours	2979.05		
Pilot-in-command						
Licence Type	Private Pilot Licence (PPL)		Gender	Male	Age: 20	
Licence Valid	Yes					
Total Hours on Type	31.12		Total Flying Hours	103.49		
People On-board	1 + 0	Injuries 0	Fatalities	0	Other (On ground)	0
What Happened						

On Friday morning, 22 July 2022, a pilot on-board a Sling 2 aircraft with registration ZU-FCT took off on a private flight from Wonderboom Aerodrome (FAWB) in Gauteng province to Brits Aerodrome (FABS) in the North West province, with the intention to land back at FAWB. Visual meteorological conditions (VMC) by day prevailed at the time of the flight. No flight plan was filed for the flight. The aircraft was operated under the provisions of Part 94 of the Civil Aviation Regulations (CAR) 2011 as amended.

The pilot stated that the aircraft had 150 litres (l) of automotive gasoline (Mogas) 95-octane fuel in the tanks during the pre-flight inspection at FAWB. Nothing abnormal was noted during the pre-flight inspection. The flight to FABS proceeded as planned. Upon arrival at FABS, the pilot conducted two touch-and-go landings, followed by a full stop landing. Thereafter, the pilot taxied the aircraft to the apron where he shut down the engine. He noted that the aircraft had 126l of fuel remaining in the tanks.

After disembarking the aircraft, the pilot went to the clubhouse. A while later, the pilot returned to the apron and conducted inspection on the aircraft in preparation for his return flight to FAWB via Klipvoor Dam. The pilot reported that the engine started normally. At approximately 1130Z after making sure the indications were within limits on the Electronic Flight Instrument System (EFIS) screen, he opened the throttle to 5800 engine revolutions per minute (RPM) and took off. The aircraft climbed to 1500 feet (ft) above ground level (AGL). After levelling off, he retarded the throttle to 5500 RPM, cruising at 90 knots (kt) indicated air speed (KIAS). After approximately 29 nautical miles (nm) from FABS and whilst overhead Klipvoor Dam, the engine lost power without warning. The pilot reported that the left fuel tank was selected when the engine lost power. Despite following the engine power loss in-flight procedure as stipulated in the Pilot's Operating Handbook (POH) by switching from the left- to the right-side fuel tank, he was unable to restore the engine power. Considering that he was unable to maintain a level flight and that FAWB was still far, the pilot decided to broadcast a Mayday call on frequency 118.35-Megahertz (MHz) to inform the air traffic control (ATC) at FAWB that he was experiencing engine problems and that he would be landing north of FAWB. During the emergency landing on a field in Pretoria General Flying (GF) area, the 'one-piece' main landing gear separated from the underbelly and the nose gear strut broke off. The pilot switched off the fuel selector, electrics and the master switch before disembarking the aircraft. The aircraft sustained substantial damages, but the pilot was not injured. Also, no third-party damage was reported. The duration of the flight was 1.5 hours. Approximately 114l of fuel remained in the tanks.

An eyewitness who was on a farm north of FAWB reported to the investigator-in-charge (IIC) that he saw a small single engine aircraft flying at low level and headed south towards FAWB. He deduced that the aircraft had engine problems because he heard it misfire.

Figure 1: The aircraft post-accident. (Source: Operator)

The pilot

The pilot had a United Kingdom Civil Aviation Authority (UK CAA) issued Private Pilot Licence (PPL). The pilot also had a European Union Class 2 aviation medical certificate that was issued on 29 July 2019 with an expiry date of 23 July 2024 with no restrictions. The pilot's foreign PPL was revalidated to the SACAA PPL on 17 March 2022 with an expiry date of 15 March 2027 and in accordance with (IAW) the South African CAR Part 61. The pilot had the aircraft type endorsed on his licence. The pilot's training was conducted by the Approved Training Organisation (ATO) at FAWB. The SACAA-approved ATO was issued the ATO certificate on 31 May 2022 with an expiry date of 31 July 2027.

The aircraft information

The Sling 2 is a two-seat, single-engine, tricycle gear aluminium experimental-amateur built aircraft with a conventional low-wing design manufactured by The Airplane Factory (TAF) in Johannesburg (JHB), South Africa. The aircraft is based upon the European Aviation Safety Agency (EASA) certification standard very light aircraft (CS-VLA), having a maximum all-up weight of 700 kilograms (kg). The aircraft is powered by a four stroke Rotax 912iS piston engine with serial number 441 with four liquid and air-cooled cylinders, driving a composite Warp drive three-blade ground adjustable propeller with serial number 1054. The engine has a rated maximum continuous power output of 100-horsepower (hp) at 5 800 RPM. The engine is equipped with two sets of electronic fuel injectors, two electrical generators, two engine control units (ECU's [Lane A and B]), dual ignition, and high-pressure electrical fuel pumps.

Fuel on the aircraft is contained in two integral fuel tanks located in the leading-edge forward of the main spar. The tank in each wing has a capacity of 98.8 United States (US) gallons (75l) of which 146l of fuel is useable. Fuel burn is approximately 18l per hour (p/h) at 5 000RPM power setting. The fuel flows from the tanks via a water separator filter to the electric fuel pumps from where it is pumped through the fine filter to the fuel pressure reading unit through the fuel rails into the fuel injectors at 3 bars (43 pressure per square inch [psi]). The fuel pump activated directly through the switch OFF/ON. A fuel pressure regulator ensures that the pressure differential between the fuel injectors and the intake manifold remains constant. This enables the fuel injection system to inject the same quantity of fuel at any point given the same injection period. Through the return line surplus fuel flows back to the fuel tank. The engine is equipped with an electronic fuel injection system. The objective of the fuel injection system is to regulate and optimize the fuel/air ratio that enters the engine. This system is controlled by the ECU, sensors and enables highly accurate metering of the fuel according to operating and load conditions, whilst at the same time also taking ambient conditions into account.

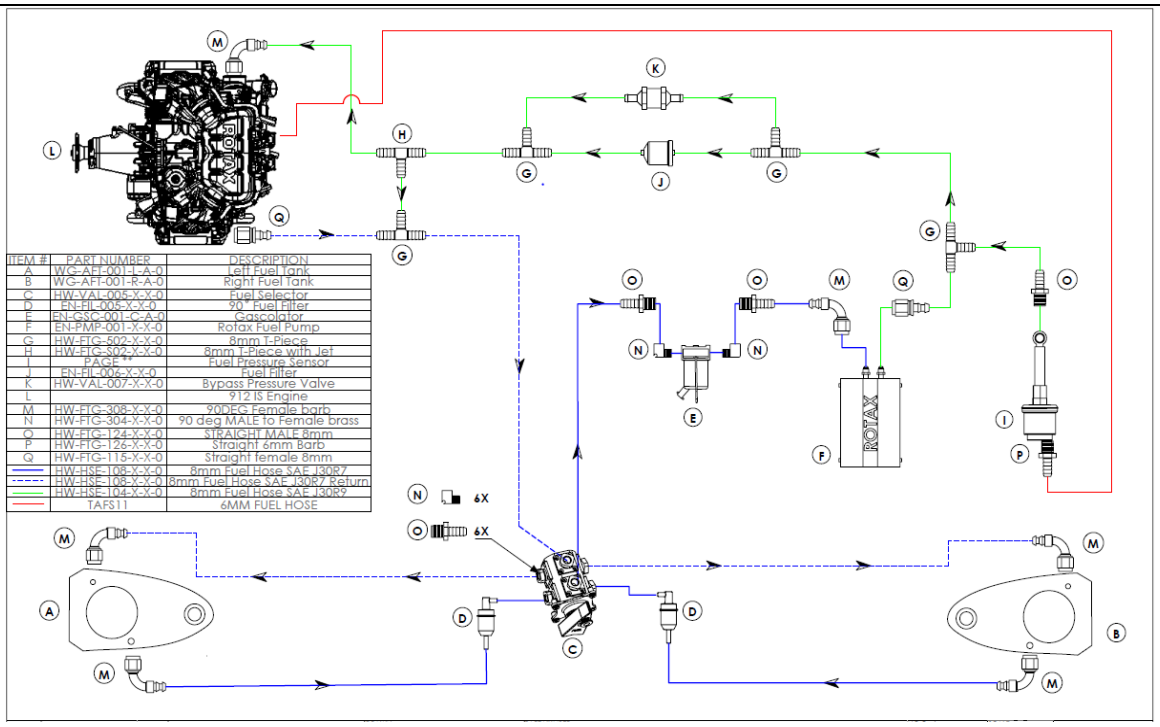


Diagram 1: The aircraft's fuel system schematic. (Source: Pilot's Operating Handbook)

According to the job card number 9899 obtained from the operator, the last 100-hour annual inspection prior to the accident flight was certified on 25 February 2022 at 2892.2 airframe hours. The maintenance entries indicated that the operator had complied with all applicable Service Bulletins (SBs) and Airworthiness Directives (ADs). The inspection was certified by an approved person (AP), endorsed by the SACAA. The aircraft was issued a Certificate of Release to Service (CRS) on 25 February 2022 with an expiry date of 24 February 2023 or at 2992.2 airframe hours, whichever occurs first. The aircraft was flown a further 86.15 hours since the last annual inspection. The aircraft's flight folio was reviewed, and there were no outstanding defect entries prior to the accident flight. The aircraft was initially issued an Authority to Fly (ATF) certificate on 15 July 2016 with an expiry date of 30 June 2023.

Post-accident investigation

All the aircraft components were accounted for at the accident site. The aircraft was assessed as being intact. The integrity of the cockpit area was not compromised. The cockpit was examined, and all the switches were set IAW the engine shutdown procedure with the fuel selector set to the middle and in the off position. Continuity of the flight controls was established. The wing flaps were extended to 20°. The propeller was examined, and it was found that one of the blades had broken near the root, which was consistent with very low or no power being delivered by the engine during the forced landing. Both wings were intact with no indication of obstruction to the fuel vents. Both the left- and the right-fuel tank caps were in place and secured; there was fuel in both tanks.

A sample of fuel was drained from the drain valves; its odour and colour was consistent with Mogas 95-octone fuel. Upon opening the cowlings, the engine was noted to be in good condition. No loose or broken fuel pipes or lines were evident. The engine check valve that is designed to allow fuel to bypass the fine fuel filter should it be clogged, showed no signs of abnormality. The fuel injection system temperature and pressure sensors were intact and correctly fitted. The oil reservoir was intact and contained sufficient oil. The induction system was examined and was found to be in a satisfactory condition. The wings were removed before the wreckage was recovered to the aircraft maintenance organisation (AMO) at FAWB for further investigation. The operator, in the presence of the IIC, downloaded data from the engine control unit (ECU) following the manufacturer's procedures. The information/flight logs that were downloaded showed a decrease in exhaust gas temperatures (EGT) for cylinders 1 and 3.

Figures 2: Flight logs indicating a drop in EGT for cylinders 1 and 3.

Another flight log showed that fuel supply through the injector nozzles for cylinders 1 and 3 was blocked, which explained the reduced EGT. Moreover, this indicated that cylinders 1 and 3 were receiving a leaner mixture whilst cylinders 2 and 4 were receiving a richer mixture. The spark plugs for cylinders 2 and 4 were clean, and the insulators and the electrodes had light grey-brown shade, indicative of normal ignition process. Carbon deposit was evident on cylinders 1 and 3 spark plugs.

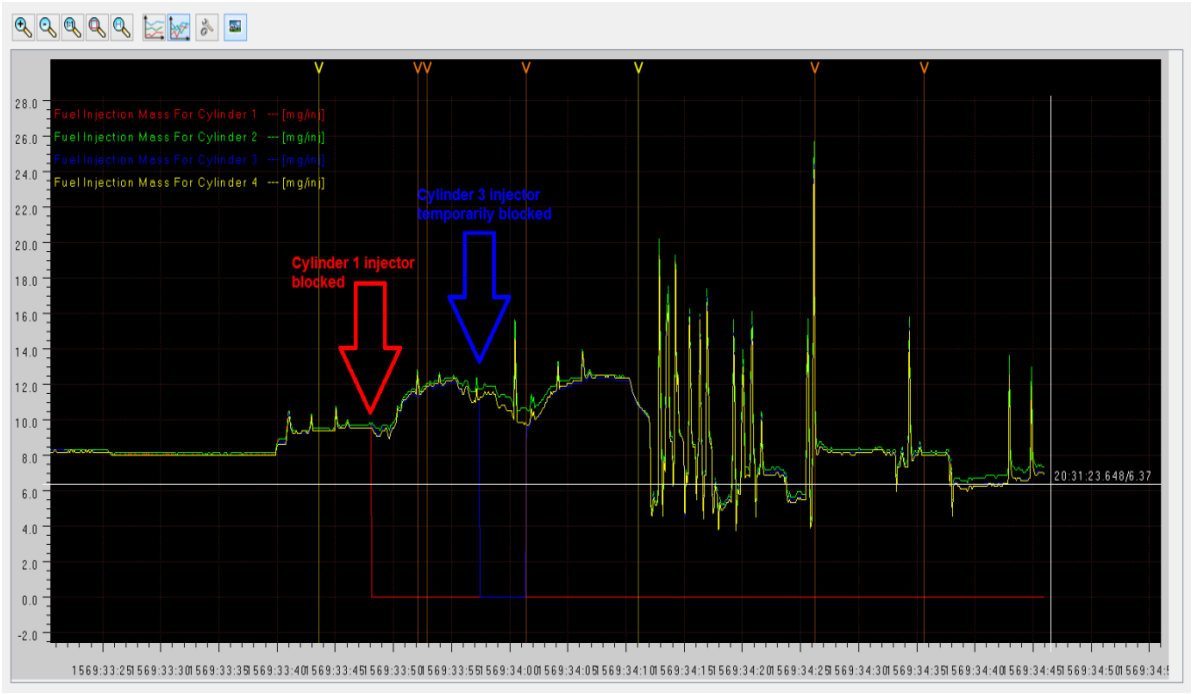
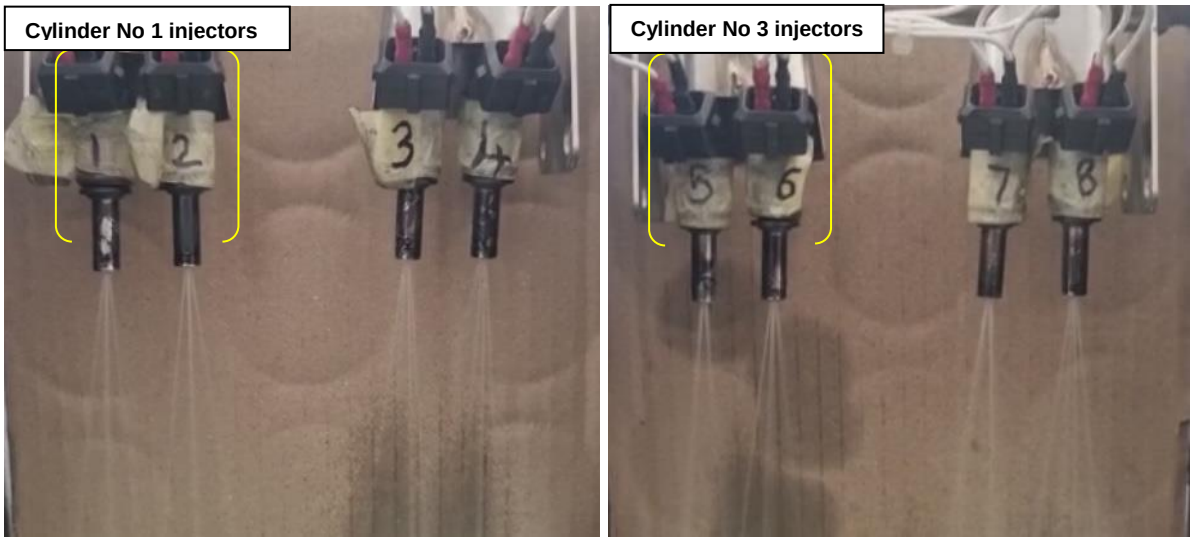


Figure 3: The ECU flight logs shows obstructed fuel injectors.

The engine was again examined in the presence of a Rotax agent for the engine type; no abnormalities were noted. The fuel system was subjected to a flow test. To test the fuel system, the fuel supply line to the fuel rail was disconnected and the fuel flow from both pumps was tested. A clean and dry container was used to capture fuel. Both pumps supplied approximately 120 litres of fuel per hour (p/h). All eight injectors were removed from the engine and were taken to a Rotax-approved agent in Gauteng, Germiston, to determine their fuel flow characteristic. All injectors were then fitted to the fuel rail. During the test at 40 pounds per square inch (psi), injectors for cylinders 1 and 3 showed irregular spray pattern caused by dirt build-up in their nozzles, which explained the engine's loss of power in-flight. The affected injector nozzles were not cleaned; however, all the built-up dirt cleared automatically as the test progressed.



Figures 4 and 5: The eight fuel injectors indicating equal and continuous spray pattern.

The electrical system/wiring to the fuel injectors was examined; no anomalies were found. Inspection of the left-wing tank revealed fuel contamination on the left-side coarse fuel filter (Figure 6). The composition of debris seemed to be metal particles and fragments of the PRC (aerospace sealant). Further inspection of the fine fuel filter showed further traces of smaller contaminants (Figure 7). The fuel pressure regulator housing was then removed to ascertain if the contaminants did not enter the fuel rail. Contaminants were found, which seemed to have obstructed the fuel injector nozzles, thus, preventing the engine from responding IAW the throttle inputs from the cockpit to obtain the desired RPM.

Figures 6 and 7: Metal particles inside the left tank fuel filter (left picture). Foreign particles found inside the fine fuel filter (right picture).

Figures 8 and 9: Dirt found inside the fuel pressure regulator (left picture). The cloth used to clean the fuel pressure regulator (right picture).

The aircraft's flight folio page serial number 12362 entry, dated 17 May 2022, indicated that the left fuel tank had undergone maintenance at 2929.96 airframe hours because it was leaking. A task card with serial number 10139, dated 23 May 2022, showed that the left-wing in-board fuel panel was removed and during the visual inspection, the fuel sender was found to be loose. The fuel sender defect was then rectified by tightening the screw and the PRC sealant was reapplied. The panel was refitted, and the fuel leak defect was resolved. The maintenance task was approved by the AP on 23 May 2022. The aircraft had been flown a further 49.09 hours since the left tank was repaired.

The fuel inventory at the operator's facility was examined and it was found that the fuel that had been delivered was stored in a mobile tank. Records showed that the fuel was certified for fuel density and that clear and bright tests were completed. Inspection of the mobile fuel tank showed that its filter assembly was last replaced on 1 April 2022. The IIC took samples of fuel from the mobile fuel tank, and later verified that the correct grade was used and that it was free of contaminants. Available information specified that the fuel type was certified for use on Rotax 912iS engines. The refuelling records were examined and were found to be up to date. The engineer responsible for refuelling was interviewed and had indicated that fuel samples are taken each morning before aircraft are refuelled. The records are kept at the operator's facility. The engineer stated that no fuel-related issues or defects were noted or reported on other aircraft that were refuelled before or after the accident aircraft.

What was found

i. The pilot's foreign PPL was revalidated to the SACAA PPL on 17 March 2022 IAW the provisions of Part 61.09.1(2)(a) of the CAR 2011 as amended, with an expiry date of 15 March 2027. The pilot had the aircraft type endorsed on his licence.
ii. The pilot had flown 31.12 hours during the past 90 days, including the accident flight, which had a duration of 1.5 hours.
iii. The flight authorisation sheet dated 22 July 2022 showed that the pilot had hired the aircraft from the ATO in FAWB with the intention to build hours.
iv. The ATO was issued the ATO certificate by SACAA on 31 May 2022 with an expiry date of 31 July 2027.
v. The flight was conducted under the provisions of Part 94 of the CAR 2011 as amended.
vi. The aircraft was initially issued an Authority to Fly (ATF) certificate on 15 July 2016. The latest renewed ATF had an expiry date of 30 June 2023.
vii. Post-accident examination of the airframe and engine did not display any signs of structural or mechanical anomalies that would have prevented normal operation.
viii. One of the blades had broken near the root, which was consistent with very low or no power being delivered by the engine during the forced landing.
ix. Examination of maintenance records showed that all applicable SBs and ADs were complied with.

x. The aircraft sustained substantial damage during the accident sequence.

xi. The pilot was not injured during the accident sequence.

Probable cause:

Loss of engine power in-flight caused by dirt that was obstructing fuel flow to the fuel injector nozzles in cylinders 1 and 3, which resulted in an unsuccessful forced landing.

Safety Action

None.

Safety Recommendation/Message

None.

Purpose of the Investigation

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (CAR) 2011, this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and ***not to apportion blame or liability****.*

About this Report

The decision regarding whether to conduct an investigation, and the scope of an investigation, are based on many factors, including the level of safety benefit likely to be obtained from an investigation. For this occurrence, a limited-scope, fact-gathering investigation was conducted in order to produce a short summary report and allow for greater industry awareness of potential safety issues and possible safety actions.

All times given in this report are Co-ordinated Universal Time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus 2 hours.

Disclaimer

This report is issued by:

Accident and Incident Investigations Division

South African Civil Aviation Authority

Republic of South Africa