LIMITED OCCURRENCE INVESTIGATION REPORT – FINAL

Reference Number	CA18/3/2/1459										
Classification	Serious Incident			**Date**	29 October 2024			**Time**	1045Z		
Type of Operation	Private (Part 91)										
Location											
Place of Departure	Springs Airfield (FASI), Gauteng Province			Place of Intended Landing				Bethlehem Aerodrome (FABM), Free State Province			
Place of Occurrence	3.7 kilometres north-east of Reitz Airfield (FARZ), Free State Province										
GPS Co-ordinates	Latitude	27º45'32.51"S		Longitude	28º23'49.90"E			Elevation	5 275ft		
Aircraft Information											
Registration	ZS-WHV										
Make; Model; S/N	Piper Aircraft Corporation; PA-28-180 (Serial Number: 28-1019)										
Damage to Aircraft	None				Total Aircraft Hours			8165.09			
Pilot-in-command											
Licence Type	Commercial Pilot Licence (CPL)				Gender	Female		Age	21		
Licence Valid	Yes	Total Hours			367.1	Total Hours on Type			125		
Total Hours 30 Days	22.2				Total Flying on Type Past 90 Days				75.4		
People On-board	1+1	**Injuries**	0	**Fatalities**	0	**Other (on the ground)**	0				

What Happened

On Tuesday, 29 October 2024, a pilot and a passenger on-board a Piper PA-28-180 Cherokee aircraft with registration ZS-WHV took off on a private flight from Springs Airfield in Gauteng province to Bethlehem Airfield (FABM) in Free State province. Visual meteorological conditions (VMC) by day prevailed at the time of the flight which was conducted under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended.

The pilot reported that he conducted a pre-flight inspection and no anomalies were found. She then performed the run-up checks and all parameters were within the green arc. Thereafter, she took off from Runway 21, climbed and cruised at 7 500 feet (ft). Approximately 30 minutes into the flight whilst en route to FABM, the engine ran rough and the revolutions per minute (rpm) gauge dropped significantly from cruise power setting of 2500 rpm to 1500 rpm. She attempted to decrease and increase the power lever, as well as lean the mixture, but with no success. After about 10 minutes of trying to identify and rectify the fault, the aircraft could not maintain height any longer and it began to descend. The pilot decided to fly to Reitz Airfield (FARZ), Free State province, which was the nearest airfield from her position, about 10 kilometres away.

At that stage, she made a distress call on Traffic Information Broadcast by Aircraft (TIBA) on frequency 124.8-Megahertz (MHz) and emergency frequency 121.5 MHz and squawked 7700 on

the transponder. After deducing that she would not reach Reitz Airfield (FARZ) as the aircraft could not maintain height, she decided to configure the aircraft to force land on a field approximately 3.7 km north-west of FARZ. She then turned off the master switch after she had brought the aircraft to a stop. The aircraft was not damaged; both occupants disembarked from the aircraft unassisted and unharmed.

The serious incident occurred during daylight at Global Positioning System (GPS) co-ordinates determined to be 27º45'32.51" South 28º23'49.90" East, at an elevation of 5 275 feet (ft).

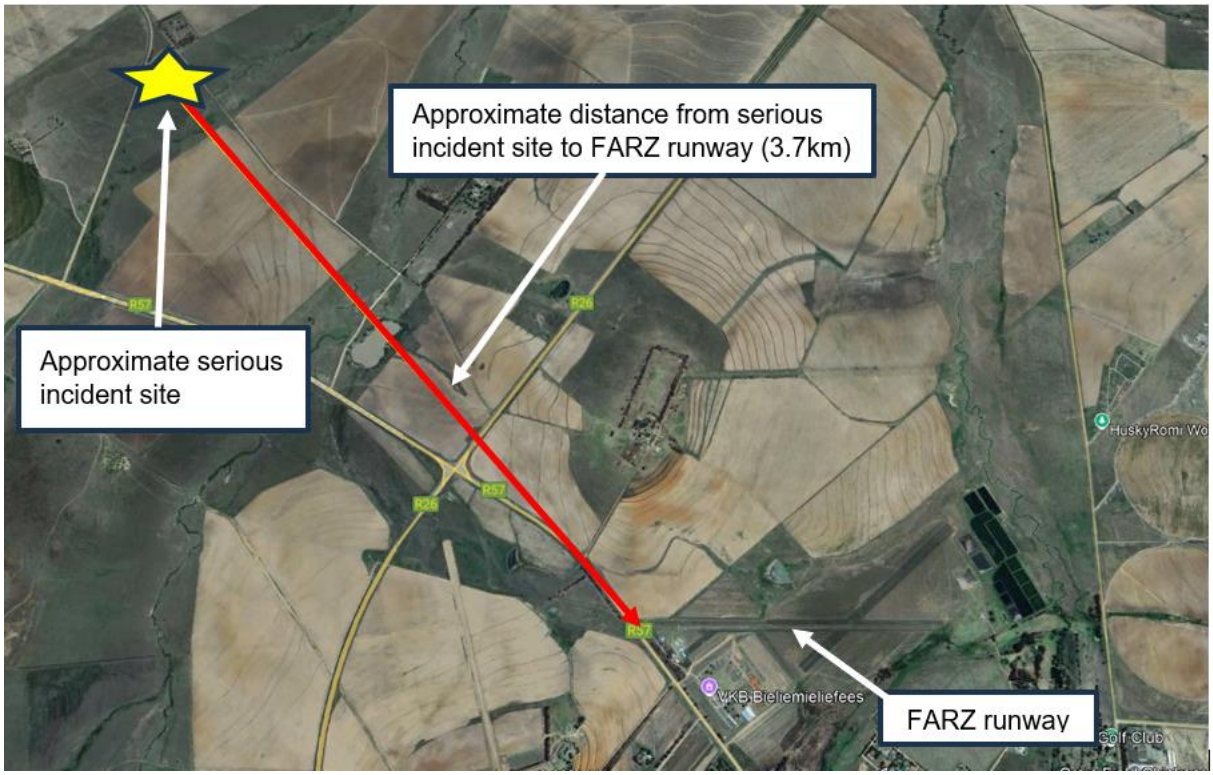

Figure 1: Aerial view of FARZ Airfield and the distance from the serious incident site. (Source: Google Earth)

Figure 2: The right-side view of the aircraft at the accident site. (Source: Pilot).

Figure 3: The rear view of the aircraft. (Source: Pilot)

Post-serious Incident Investigation

On Monday afternoon, 30 October 2024, the aircraft maintenance engineers (AMEs) recovered the aircraft to the South African Civil Aviation Authority-approved aircraft maintenance organisation (AMO) at FASI. The engineers, in the presence of the investigator, inspected the engine for damage, and found no anomalies. About 136 litres of fuel remained in the tanks; the fuel was free of contaminants. The Lycoming engine with serial number L-5582-36 was inspected as per the instructions outlined in the operator's manual. The spark plugs were removed, and four of the eight spark plugs were found contaminated with oil and carbon deposits (see Figure 4).

According to the reviewed maintenance history, the spark plugs were installed during the engine overhaul on 12 July 2021. According to the Pilot's Operating Handbook (POH), the spark plugs are on-condition items that are inspected every 100 hours. At the time of the serious incident, they had accumulated 480 hours (hrs) with four inspection intervals conducted. Figure 4 shows the eight spark plugs that were removed from the aircraft after the serious incident. Four of them were contaminated with oil and carbon deposits which reduced engine performance because they were not producing sparks, whilst the other four were in good condition and operated normally.

Figure 4: The yellow circle indicates the fouled spark plugs.

A normal spark plug would have brown or greyish deposits on the side electrode.

Figure 5: Bronw deposits.

Figure 6: Greyish deposits.

Description and Operation of the Spark Plugs (Source: FAA-H-8083-32B)

The function of the spark plug in an ignition system is to conduct a short impulse of high-voltage current through the wall of the combustion chamber. Inside the combustion chamber, it provides an air gap across which the impulse can produce an electric spark to ignite the air-fuel charge. While the aircraft spark plug is simple in construction and operation, it can be the cause of malfunctions in aircraft engines. Despite this fact, spark plugs provide a great deal of trouble-free operation when properly maintained and when correct engine operating procedures are practiced.

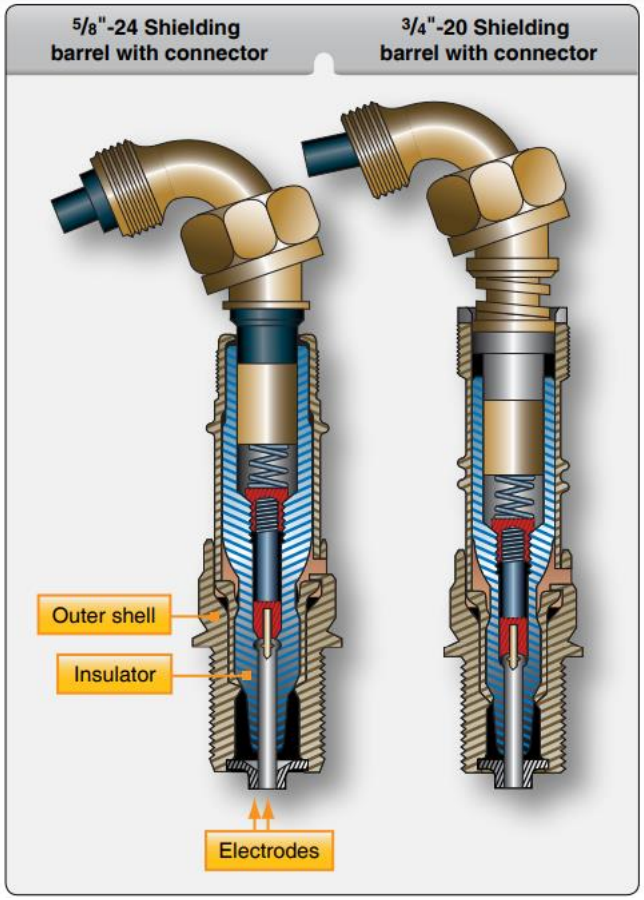

Figure 7: Spark plug cross-section.

On 15 June 1998, the Federal Aviation Administration (FAA) issued an Advisory Circular (AC) number 20-105B

Subject: RECIPROCATING ENGINE POWER- LOSS ACCIDENT PREVENTION

Spark Plug Fouling:

Spark plugs that consistently foul can be an indication of worn rings, excessive rich mixture, improper spark plugs heat range, short ignition harness, cracked cigarettes, wrong fuel, spark plug barrels that are dirty or wet with moisture, ignition timing off, low speed and idle, improper leaning procedures and rapid cool down of the engine in long gliding descents.

Frequent inspection, cleaning, gapping, and rotation of the spark plugs may prove helpful in reducing fouling.

Further investigation revealed that the oil and carbon deposits on the spark plugs resulted from worn-out oil control rings (see Figure 7). According to the Lycoming Engine Overhaul Manual, the piston rings, including the oil control rings, are on-condition items which are inspected during engine overhaul. The engine is overhauled every 2000 hours. According to the maintenance records, the engine was overhauled four times, with the last overhaul conducted on 12 July 2021 at 7685.09 hours. The engine had been operated for 480 hours when the oil control rings became worn out.

During the compression test, the oil control rings were found to have lost sufficient radial tension to seal the pistons effectively. The measurements indicated that the clearance between the piston ring and the ring groove exceeded the worn-out limit of 0.006 inches. The Lycoming engine overhaul manual specifies that the clearance between the piston ring and the groove should be between 0.0015 and 0.0035 inches.

Worn-out Oil Control Rings Can Lead to Several Issues. Source: Powerplant (FAA-H-8083-32B)

1. Excessive Oil on Cylinder Walls

A worn-out oil control ring fails to scrape excess oil from the cylinder walls effectively. This allows excessive oil to enter the combustion chamber.

2. Oil Fouling of Spark Plugs

- *The excess oil burns along with the air-fuel mixture during combustion.*
- *This burning oil produces carbon deposits and leaves a residue on the spark plug electrodes.*
- *The spark plugs become oil-fouled, reducing their ability to generate a strong spark.*

3. Reduced Engine Performance

- *Oil-fouled spark plugs lead to misfiring or incomplete combustion.*
- *This results in reduced engine performance, poor fuel efficiency, and increased exhaust emissions.*

Visual Symptoms:

- *Spark plugs removed from the engine may appear wet or coated in a black, oily substance, indicative of oil fouling.*

Figure 8: Worn oil control rings.

Description and Operation of the Oil Control Rings
Source: Powerplant (FAA-H-8083-32B)

Oil control rings are placed in the grooves immediately below the compression rings and above the piston pin bores. There may be one or more oil control rings per piston; two rings may be installed in the same groove, or they may be installed in separate grooves. Oil control rings regulate the thickness of the oil film on the cylinder wall. If too much oil enters the combustion chamber, it burns and leaves a thick coating of carbon on the combustion chamber walls, the piston head, the spark plugs, and the valve heads. This carbon can cause the valves and piston rings to stick if it enters the

ring grooves or valve guides. In addition, the carbon can cause spark plug misfiring as well as detonation, pre-ignition, or excessive oil consumption. It works alongside the compression rings to maintain a proper seal, ensuring efficient engine compression and performance.

The Pilot's Operating Handbook for the PA-28-180 outlines the following procedures for run-up checks.

- *Return to idle and verify RPM is stable.*
- *Ensure the engine runs smoothly and does not stall.*
- *Confirm that all parameters are in the green range.*
- *Reduce to idle (approximately 800 RPM) to verify idle operation before setting back to taxi or take-off RPM.*

Meteorological Conditions

The pilot provided the following weather information for FARZ on 29 October 2024 through the pilot's questionnaire form.

Wind Direction	270°	Wind Speed	11kts	Visibility	9999m
Temperature	24°C	Cloud Cover	SCT	Cloud Base	4800
Dew Point	15°C	QNH	1028hPa		

Findings

Pilot

1) The pilot was initially issued a Commercial Pilot Licence (CPL) on 1 December 2022. Her last revalidation was conducted on 25 January 2024 with an expiry date of 31 January 2025. The aircraft type was endorsed on the pilot's licence. Her Class 4 aviation medical certificate was issued on 30 November 2023 with an expiry date of 30 November 2024. The pilot was suitably qualified and authorised to conduct the flight.

Aircraft

2) The aircraft's Certificate of Registration (C of R) was issued to the current owner on 3 April 2019. The Certificate of Airworthiness (C of A) was initially issued on 17 March 2021. The C of A was reissued on 17 March 2024 with an expiry date of 31 March 2025.

3) The last annual inspection of the aircraft was certified on 29 September 2024 at 8084.86 total airframe hours. At the time of the flight, the aircraft had a total of 8165.09 airframe hours. The aircraft was flown a further 80.23 hours since the last inspection.

4) The aircraft was issued a Certificate of Release to Service (CRS) on 27 September 2024 at 8084.86 airframe hours with an expiry date of 27 September 2025 or at 8184.86 airframe hours, whichever occurs first.

5) A pre-flight inspection was conducted, and the aircraft was deemed ready for the flight. No defects were recorded in the flight folio before the flight.

6) The engine was equipped with eight spark plugs, four of which were contaminated; this reduced engine performance. The other four spark plugs were in good condition. The affected spark plugs were caused by the worn-out oil control rings.

7) The worn-out oil control rings caused excessive oil on cylinder walls which led to the fouling of the spark plugs with oil and carbon deposits. This resulted in reduced engine performance.

8) Although the pilot stated that all was normal during the run-up checks, she might not have realised that the engine was not functioning as per the prescription in the manual instructions.

Environment

9) Good weather conditions prevailed at the time of the flight. The weather was not a contributing factor to this accident.

Probable Cause

The aircraft's engine lost power due to the fouled spark plugs which were contaminated as a result of worn-out oil control rings. The pilot successfully executed a forced landing on an open field.

Contributing Factor

Poor maintenance.

Safety Action(s)

None.

Safety Message

None.

About this Report

The decision to conduct a limited investigation is based on factors including whether the cause is known and the evidence supporting the cause is clear, the level of safety benefit likely to be obtained from an investigation and that will determine the scope of an investigation. For this occurrence, a limited investigation has been conducted, and the Accident and Incident Investigations Division (AIID) has relied on the information submitted by the affected person/s and organisation/s to compile this limited report. The report has been compiled using information supplied in the initial notification, as well as from follow-up desktop enquiries to bring awareness of potential safety issues to the industry in respect of this occurrence, as well as possible safety action/s that the industry might want to consider in preventing a recurrence of a similar occurrence.

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.
Purpose
In terms of Regulation 12.03.1 of the Civil Aviation Regulations (CAR) 2011 and ICAO Annex 13, 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.
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This report is issued by:
Accident and Incident Investigations Division
South African Civil Aviation Authority
Republic of South Africa