SOUTH AFRICAN CIVIL AVIATION AUTHORITY

Section/division **Accident and Incident Investigations Division** Form Number: CA 12-57

LIMITED OCCURRENCE INVESTIGATION REPORT – FINAL

Reference Number	CA18/2/3/10138						
Classification	Accident	**Date**	27 March 2022		**Time**	1030Z	
Type of Operation	Training (Part 141)						
Location							
Place of Departure	Lanseria International Aerodrome (FALA)	Place of Intended Landing	Lanseria International Aerodrome (FALA)				
Place of Occurrence	Open field near Hartbeespoort, North West Province						
GPS Co-ordinates	Latitude	25° 50' 22.31" S	Longitude	27° 49' 20.31" E	Elevation	4 612 ft	
Aircraft Information							
Registration	ZS-PFC						
Make; Model; S/N	Cessna 172H Skyhawk (Serial Number: 172-55742)						
Damage to Aircraft	Substantial	Total Aircraft Hours	10 080.93				
Pilot-in-command							
Licence Type	Commercial Pilot Licence (CPL) Aeroplane	Gender	Male	Age	31		
Licence Valid	Yes	Total Hours on Type	179.4	Total Flying Hours	495		
People On-board	2 + 0	**Injuries**	2	**Fatalities**	0	**Other (on ground)**	0

What Happened

On 27 March 2022, a flight instructor (FI) and a student pilot (SP) on-board a Cessna 172H (Skyhawk) aircraft with registration ZS-PFC departed Lanseria International Aerodrome (FALA) in Gauteng province on a training flight to practise stall exercises at the general flying area (GFA) (FAD 70E) and, thereafter, return to the take-off aerodrome. No flight plan was filed for the flight, which was conducted under visual flight rules (VFR) by day and under Part 141 of the Civil Aviation Regulations (CAR) 2011 as amended.

According to the FI, the SP was on the controls. About 10 minutes into the flight after levelling off at 5 500 feet (ft) above mean sea level (AMSL), the FI requested that the SP open the throttle lever to the maximum power setting and climb further to 6 000ft AMSL; however, the engine did not respond. The FI then took control of the aircraft and followed the in-flight engine failure checklist by changing fuel tanks, adjusting the fuel mixture to full rich and changing magnetos, but the revolutions per minute (RPM) indication kept fluctuating between 1000 and 1500. The aircraft started to lose height thereafter.

The FI sought out an open field ahead of the aircraft's flight path on which to conduct a forced landing. The FI then switched off the engine and glided the aircraft to the identified open field.

Upon touchdown, the FI realised that the terrain sloped upwards and was rugged and dotted with anthills. During the landing roll, the nose wheel collided with an anthill that was approximately 40 centimetres (cm) high. This led to the nose-gear strut breaking off and causing the aircraft to nose over. It came to a halt in an inverted position approximately 86 metres (m) from the first point of impact.

The aircraft was substantially damaged, and both pilots sustained minor injuries during the accident sequence.

Figure 1: The aircraft post-accident.

Figure 2: (a) The anthill with which the nose gear collided. **(b)** Location of the nose landing gear strut in relation to the main wreckage.

What was found

1. Personnel Information:

1.1. The FI was reissued a Commercial Pilot Licence (CPL) on 4 April 2021 with an expiry date of 30 April 2022. The FI acquired an Instructor Grade 3 rating on 1 July 2021 with an expiry date of 31 July 2022. The Cessna 172H aircraft type was endorsed on the FI's licence. A Class 1 medical certificate was issued to the FI on 8 March 2022 with an expiry date of 31 March 2023, and with the restriction to wear suitable corrective lenses.

1.2. The SP was issued a Student Pilot Licence (SPL) on 7 February 2022 with an expiry date of 6 February 2023. The Cessna 172H aircraft type was endorsed on the SP's licence. A Class 2 medical certificate was issued to the SP on 18 January 2022 with an expiry date of 18 January 2027, with the restriction to wear suitable corrective lenses.

1.3. Both pilots were licensed and qualified for the flight in accordance with existing regulations.

2. Aircraft Information:

2.1. According to the aircraft's latest Certificate of Release to Service (CRS), the latest mandatory periodic inspection (MPI) was certified on 17 March 2022 at 10 048.00 total hours. At the time of the accident, the aircraft had accumulated 10 080.93 hours, which meant that it had been flown for a further 32.93 hours since the last MPI.

2.2. The last MPI was carried out by an aircraft maintenance organisation (AMO) with a valid approval certificate. The aircraft maintenance engineer (AME) who certified the last MPI was appropriately licensed to carry out maintenance on the aircraft type.

2.3. Aircraft logbooks and maintenance history were scrutinised, and all documents were found to be in order. All applicable Service Instructions (SIs), Service Bulletins (SBs) and Airworthiness Directives (ADs) were complied with.

2.4. Engine overhaul work pack was scrutinised, and it was found to be in line with the operator's Overhaul Manual.

2.5. The aircraft had a valid Certificate of Airworthiness and was maintained in compliance with the regulations. The aircraft was deemed airworthy when it dispatched for the flight.

2.6. The engine (Lycoming O-320-E2A) was bench-tested at the engine shop/facility, and it ran smoothly at all power settings.

2.7. The carburettor heat lever was found in the fully in (cold) position. The pilots did not use the carb heat lever when they experienced loss of engine power.

2.8. The aircraft was substantially damaged by impact forces, and the occupants sustained minor injuries during the accident sequence.

3. Carburettor Icing:

3.1. The weather information below was obtained from the Meteorological Aerodrome Report (METAR) that was issued by the South African Weather Service (SAWS) which was recorded on 27 March 2022 at 1020Z at FALA, located 8 nautical miles (NM) from the accident site.

Wind Direction	350 °	Wind Speed	05 kt	Visibility	9999 m
Temperature	24 °C	Cloud Cover	CAVOK	Cloud Base	SCT035
Dew Point	13 °C	QNH	1024 hPa		

The carburettor (carb) icing chart shows that the weather conditions were conducive for moderate icing at cruise power or serious icing at descent power with 50% relative humidity (refer to the black solid and dotted lines, as well as the round spot on the graph below).

Temperature	24 °C
Dewpoint	13 °C
Dewpoint depression	11 °C

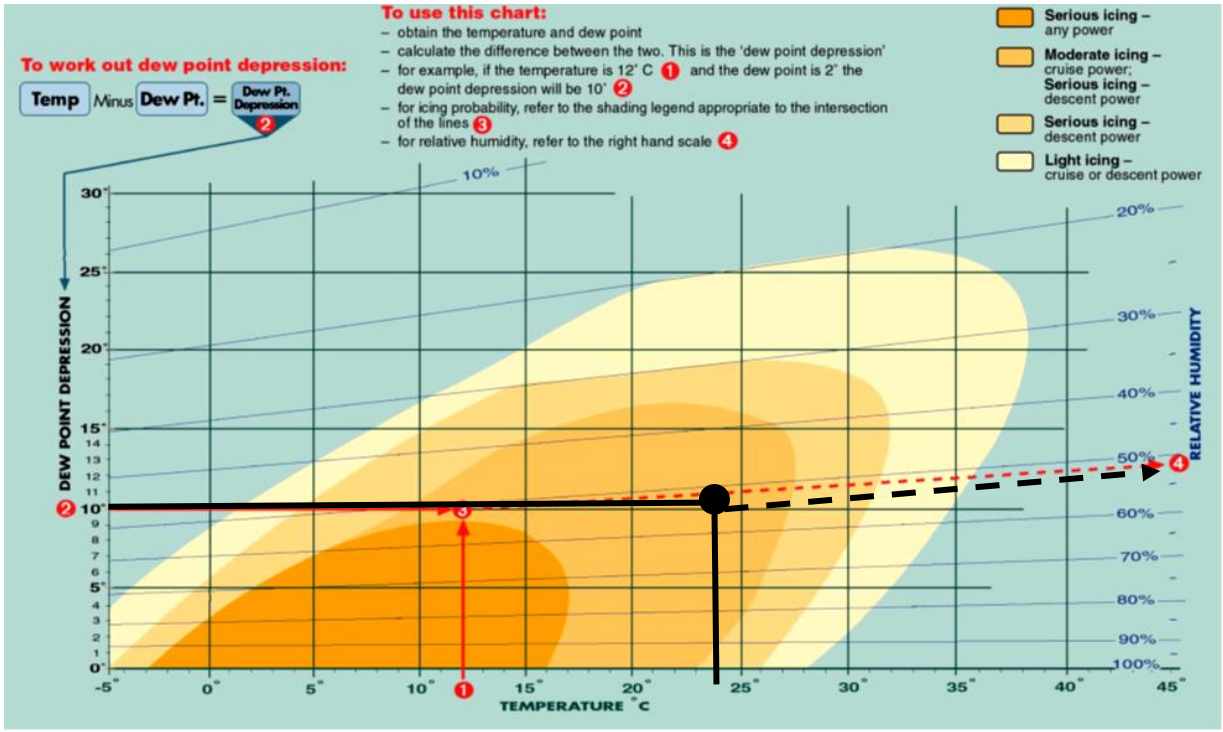

Figure 3: The Carburettor Icing-probability Chart.

3.2. **According to the *Lycoming O-320 (76 Series) Operator's Manual***

The Lycoming O-320 aircraft engine is a four-cylinder direct drive, horizontally opposed, wet sump, carburetted, air cooled engine. The engine is equipped with a Marvel-Schebler single barrel, float type carburettor, equipped with a manual mixture control and idle cut-off. Distribution of the fuel-air mixture is obtained through the centre zone induction system, which is integral with the oil sump and is submerged in oil, insuring a more uniform vaporization of the fuel, and aiding in cooling the oil in the sump. From the riser the fuel-air mixture is distributed to each cylinder by individual intake pipes.

3.3. **According to the *Lycoming Service Instruction No: 1148C of 12 October 2007 for the Use of Carburettor Heat Control***

SUBJECT: Use of Carburettor Heat Control
MODELS AFFECTED: All Lycoming engines using float type carburettors.
TIME OF COMPLIANCE: During engine operation.

WARNING
REFER TO THE PILOT'S OPERATING HANDBOOK OR AIRFRAME MANUFACTURER'S MANUAL FOR ADDITIONAL INSTRUCTIONS ON THE USE OF CARBURETOR HEAT CONTROL. INSTRUCTIONS FOUND IN EITHER PUBLICATION SUPERSEDE THE FOLLOWING INFORMATION.

Under certain moist atmospheric conditions (generally at a relative humidity of 50% or greater) and at temperatures of 20° to 90°F (-6°C to 32°C) it is possible for ice to form in the induction system. Even in summer weather ice may form. This is due to the high air velocity through the carburettor venturi and the absorption of heat from this air by vaporization of the fuel. The temperature in the mixture chamber may drop as much as 70°F (21°C) below the temperature of the incoming air. If this air contains a large amount of moisture, the cooling process can cause precipitation in the form of ice. Ice formation generally begins in the vicinity of the butterfly and may build up to such an extent that a drop in power output could result. In installations equipped with fixed pitch propellers, a loss of power is reflected by a drop in manifold pressure and RPM. In installations equipped with constant speed propellers, a loss of power is reflected by a drop in manifold pressure. If not corrected, this condition may cause complete engine stoppage.

The following outline is the proper method of utilizing the carburettor heat control:

Climbing – When climbing at part throttle power settings of 80% or above, set the carburettor heat control in the full cold position; however, if it is necessary to use carburettor heat to prevent icing it is possible for engine roughness to occur due to the over-rich fuel/air mixture produced by the additional carburettor heat. When this happens, lean the mixture with the mixture control only enough to produce smooth engine operation. Do not continue to use carburettor heat after flight is out of icing conditions and return mixture to full rich when carburettor heat is removed.

Flight Operation – During normal flight, leave the carburettor air heat control in the full cold position. On damp, cloudy, foggy, or hazy days, regardless of the outside air temperature, be alert for loss of power. This will be evidenced by an unaccountable loss in manifold pressure or RPM or both, depending on whether a constant speed or fixed pitch propeller is installed on the aircraft. If this happens, apply full carburettor air heat, and open the throttle to limiting manifold pressure and RPM. This will result in a slight additional drop in manifold pressure, which is normal, and this drop will be regained as the ice is melted out of the induction system. When ice has been melted from the induction system, return the carburettor heat control to the full cold position. In those aircraft equipped with a carburettor air temperature gauge, partial heat may be used to keep the mixture temperature above the freezing point of water (32°F or 0°C).

4. Flight Operations:

4.1. The operator was in possession of an Approved Training Organisation (ATO) certificate endorsed by the SACAA, which was issued on 15 February 2022 with an expiry date of 28 February 2027. The aircraft was authorised to operate under the ATO and was included in the ATO's Operations Specifications (OpSpec) by the SACAA.

5. Operator's Pilot Checklist:

5.1. The flight school had summarised the engine failure procedures from the aircraft's Pilot's Operation Handbook (POH) into their *pilot's checklist,* which is a booklet used for pre-flight briefings, as well as used by students as a quick reference handbook in cases of emergency in-flight. The checklist contains a section on *Emergencies* (see Figure 4**:** Engine Failure Procedures from the ATO's checklist.

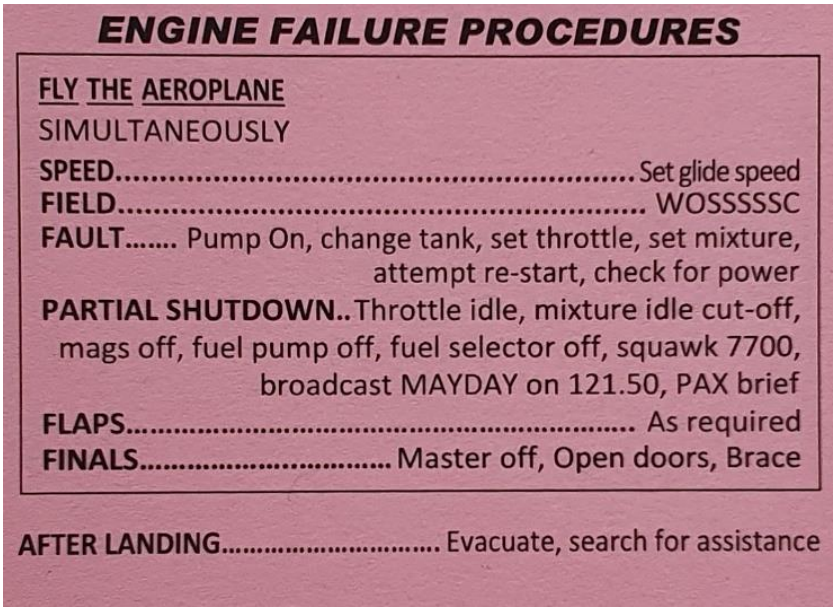

Figure 4: Engine Failure Procedures from the ATO's checklist.

5.2. The pilots followed the checklist for an engine failure during flight, listed in the *pilot's checklist* supplied by the ATO. Based on the *Partial Shutdown* section of the checklist, there is no requirement to switch the Carb heat control to the "ON" position (lever in the fully out position).

5.3. According to the *Cessna 172H Operator's Manual,* for flight operations, pilots are guided to take-off with carburettor heat off and to avoid excessive leaning in cruise. Pilots are further guided to use carburettor heat to overcome any occasional engine roughness.

Probable Cause

Ice formation in the carburettor occurred during the climb at a cruise altitude of 5 500ft AMSL, which led to the reduction in engine power. This resulted in loss of altitude and a subsequent unsuccessful forced landing.

Contributing Factors

1. The pilots did not obtain weather information (temperature and dew point) before undertaking the flight to determine whether the weather conditions were conducive for carburettor icing. Therefore, the pilots were not aware that they were flying in conditions in which carburettor ice accumulation was possible and, consequently, could not take the appropriate remedial actions.

2. The ATO's pilot's checklist does not guide pilots to select the carburettor heat control to the "ON" position to overcome any occasional engine roughness.

Safety Action/s

None.

Safety Recommendations

1. The flight school *pilot's checklist* does not contain emergency procedures/guidelines for recovering or preventing carburettor icing. The AIID recommends that the school includes a section detailing recovery procedures after experiencing carburettor icing in their pilot's checklist under engine failure during flight. Additionally, the ATO should stipulate that pilot's reference the aircraft's POH in addition to the supplied pilot's checklist.

2. Pilots flying carburettor engines should always check the temperature and dew point before take-off to determine whether the conditions are conducive for carburettor icing. Pilots are reminded that serious carburettor icing could occur in ambient temperatures as high as 32°C or in relatively humid conditions as low as 35 percent at cruise power. The AIID recommends that the flight school makes it mandatory for pilots to obtain weather information before each flight. This will ensure that the pilots are aware of the weather conditions and would be able to prevent carburettor icing from forming in conducive conditions.

About this Report

Decisions regarding whether to investigate, 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 to compile this limited report and allow for greater industry awareness of potential safety issues as well as possible safety action/s that the industry might want to consider in preventing a reoccurrence.

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****.*

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