SOUTH AFRICAN CIVIL AVIATION AUTHORITY

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

LIMITED ACCIDENT INVESTIGATION REPORT

Reference Number	CA18/2/3/10129						
Classification	Accident	**Date**	25 February 2022		**Time**	0735Z	
Type of Operation	Training (Part 141)						
Location							
Place of Departure	Lanseria International Aerodrome (FALA), Gauteng Province		Place of Intended Landing		Lanseria International Aerodrome (FALA), Gauteng Province		
Place of Accident	Open field, approximately 1.1 nautical miles (nm) from the threshold of Runway 07 at FALA						
GPS Co-ordinates	Latitude	25°57'26.80" S	Longitude	027°53'47.40" E		Elevation	4411ft
Aircraft Information							
Registration	ZS-FIF						
Make/Model	Cessna 172I (Serial Number: 172-56705)						
Damage to Aircraft	Substantial		Total Aircraft Hours		12 657.8		
Pilot-in-command							
Licence Type	Student Pilot Licence		Gender	Male		Age: 21	
Licence Valid	Yes						
Total Hours on Type	58.5		Total Flying Hours		58.5		
People On-board	1 + 0	Injuries	1	Fatalities	0	Other (On ground)	0
What Happened							

On Friday morning, 25 February 2022 at 0432Z, a student pilot on-board a Cessna 172 aircraft with registration ZS-FIF took off on a solo cross-country navigational flight from Lanseria International Aerodrome (FALA). The flight was conducted under the provisions of Part 141 of the Civil Aviation Regulations 2011 as amended. A flight plan was filed, and the fuel endurance was recorded as five hours.

The student pilot flew from FALA to Brits Aerodrome (FABS), Warmbaths Aerodrome (FAWB) and Pilanesberg Aerodrome (FAPN), where he performed a touch-and-go landing; from there he flew to Rustenburg Aerodrome (FARG) whereafter he returned to FALA with the intention to perform a full stop landing. Following radio communication with air traffic control (ATC) at FALA, the aircraft was cleared to land on Runway 07. The student pilot was number two for landing. Ahead of him was a Cessna 172 (ZS-IRA) and behind him was another Cessna 172 (ZS-OHK).

The student pilot stated that while on final approach, the engine started running rough and later stopped. He then attempted to restart the engine and it cranked, but did not restart. He then opted to do a forced landing on an open field he had identified from the air. Prior to conducting a forced landing, the student pilot had broadcasted on the FALA tower frequency 124.00-Megahertz (MHz), *"I have engine failure, FIF".* The ATC replied; *"Continue with the approach for Runway 07",* whereupon the student pilot replied; *"Copy continue Runway 07".* There was no further communication between the pilot and ATC.

During the forced landing, approximately 50m after touchdown on the open field, the aircraft collided with a concealed embankment of about 40 centimetre (cm) in height. The aircraft's nose wheel broke off and the aircraft nosed over and came to rest in an inverted attitude approximately 1.1 nautical miles (nm) from the threshold of Runway 07.

The crew of the ZS-OHK aircraft communicated with ATC and requested permission to orbit overhead ZS-FIF in the area where the student pilot had performed a forced landing. Following confirmation from the crew of ZS-OHK that the ZS-FIF had crashed, ATC activated the crash alarm and the Aerodrome Rescue and Firefighting (ARFF) personnel responded to the scene.

The student pilot was attended to at the scene by emergency medical personnel who had dispatched to the accident site. The student pilot sustained several facial lacerations and he was taken to hospital. He had also strained some muscles on his left shoulder and was given a protective brace to support his arm. The student pilot had made use of the aircraft's safety harness, which included the shoulder harness. During an interview with the student pilot, he stated that his injuries were mainly caused by the portable fire extinguisher that had detached from its mounting bracket in the cabin when the aircraft nosed over.

The duration of the flight was three hours and thirty minutes (3.5 hours), this included the time from startup, pilot obtaining taxi clearance and take-off clearance from ATC at FALA. This information was obtained from the flight folio and the Hobbs Meter reading as well as air traffic control records. During the recovery of the aircraft, a total of 45 litres of Avgas 100LL fuel was drained from the tanks.

Figure 1: Overlay of where the accident (ZS-FIF) occurred in relation to FALA. (Source: Google Earth)

Figure 2: The aircraft as it came to rest.

Figure 3: A side view of the aircraft in its resting position post-accident.

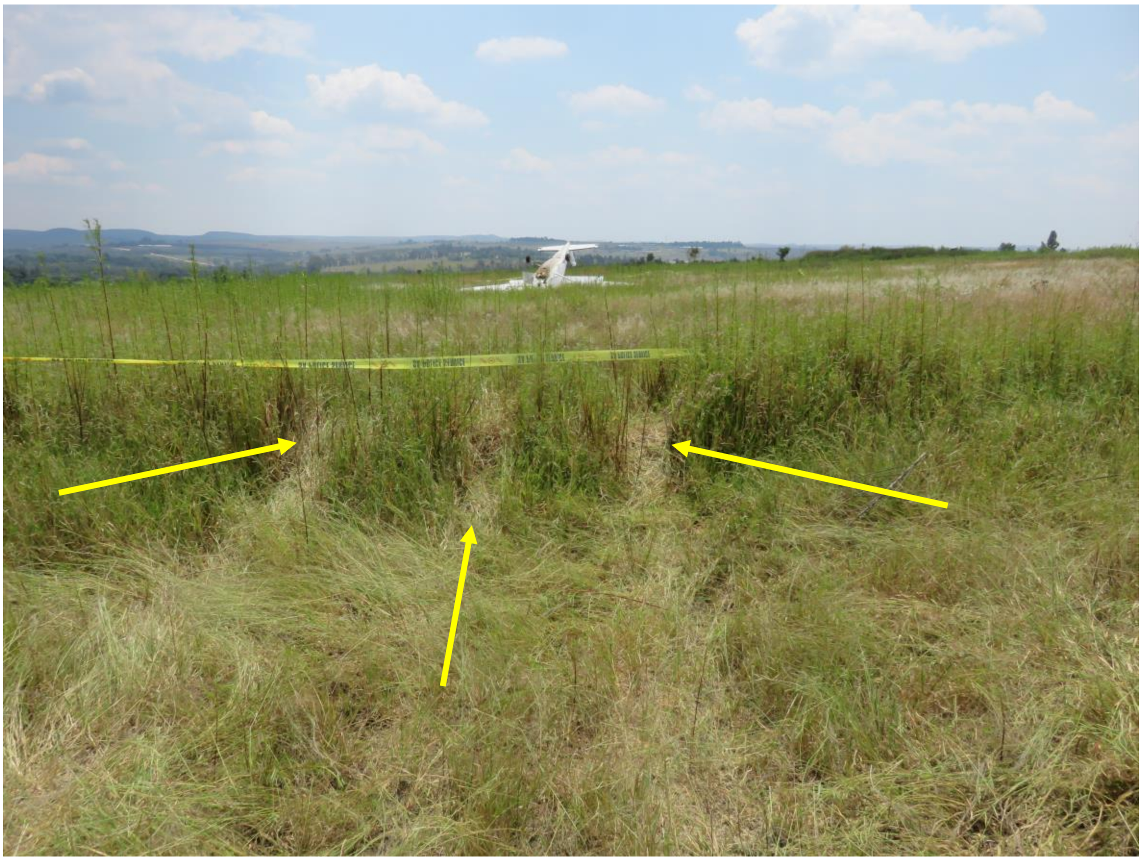

Figure 4: The wheel tracks of the aircraft and the embankment, indicated by the yellow arrows.

The Student Pilot

The student pilot was issued a Student Pilot Licence by the Regulator (SACAA) on 23 July 2021 with an expiry date of 22 July 2022. The aircraft type (C172) was endorsed on his licence. At the time of the accident, the student pilot had flown a total of 58.5 hours of which 13.7 hours were solo flying and 57.9 hours were on the aircraft type.

The Aircraft

The aircraft, a Cessna 172I with serial number 172-56705 was manufactured in 1968. The last maintenance inspection prior to the accident flight was carried out on 14 February 2022 at 12 623.9 airframe hours. A further 33.9 hours were flown since inspection. The aircraft was fitted with a Lycoming O-320-E2D engine with serial number L-23757-27A. The engine total hours at the time of the accident were 4 532.9, and 333.3 hours since overhaul. The aircraft was issued a Certificate of Airworthiness on 25 May 2017 with an expiry date of 31 May 2022.

Aircraft accident history

1. On 29 July 2006 during landing on Runway 18 at FABB, the nose gear collapse (CA18/2/3/8157).
2. On 11 October 2012 during landing at Welgevonden Game Reserve, the nose gear broke off (CA18/3/2/0943).

The ATO

The approved training organisation (ATO) was issued an ATO certificate by the Regulator on 31 March 2021 with an expiry date of 31 March 2026. The flight was entered in the Flight Authorisation Sheet as a solo navigation flight and was accordingly authorised by a flight instructor.

Before Landing Checklist (POH)

1. *Fuel Selector Valve Handle - "BOTH".*
2. *Mixture – RICH.*
3. *Propeller – High RPM.*
4. *Cowl flaps – CLOSED.*
5. *Carburettor Heat – Apply before closing throttle.*
6. *Airspeed – 80 to 90 mph (flaps retracted).*
7. *Wing Flaps - 0° to 40° (below 110 mph).*
8. *Airspeed – 70 to 80 mph (flaps extended).*
9. *Elevator and rudder trim – Adjust.*

Emergency Landing Without Engine Power (POH)

If an engine stoppage occurs, establish a flaps-up glide. If time permits attempt to restart then engine by checking for fuel quantity, proper fuel selector valve position, and mixture control setting. Also check the engine primer is full in and locked and ignition switch is properly positioned. If all attempts to restart the engine fail, and a forced landing is imminent, select a suitable field and prepare for the landing as follows:

1. *Seats and seat belts - Secure*
2. *Airspeed – 70 KIAS (Flaps Up), 65 KIAS (Flaps Down)*
3. *Pull mixture control to idle cut-off position.*
4. *Turn fuel selector valve handle "OFF".*
5. *Turn all switches "OFF" except master switch.*
6. *Extend wing flaps as necessary within gliding distance of field.*

Below 500 feet

7. *Turn Master switch "OFF".*
8. *Unlatch cabin doors prior to final approach.*
9. *Land in a slight tail-low attitude.*
10. *Apply heavy braking while holding full up elevator.*

Weather Information

An official weather report was obtained from the South African Weather Service (SAWS) for the day and time of the accident, which is contained in the table below. Conclusion: The surface forecasts and observations indicated that no significant weather was expected or occurred at that time over FALA at 0735Z.

Wind Direction	020°	Wind Speed	2 knots	Visibility	> 10km
Temperature	23.1°C	Cloud Cover	CAVOK	Cloud Base	Nil
Dew Point	13.8°C	Humidity	56%		

Carburettor Icing-probability Chart

According to the carburettor icing-probability chart, serious icing conditions could have been encountered during descent with the prevailing weather conditions at the time.

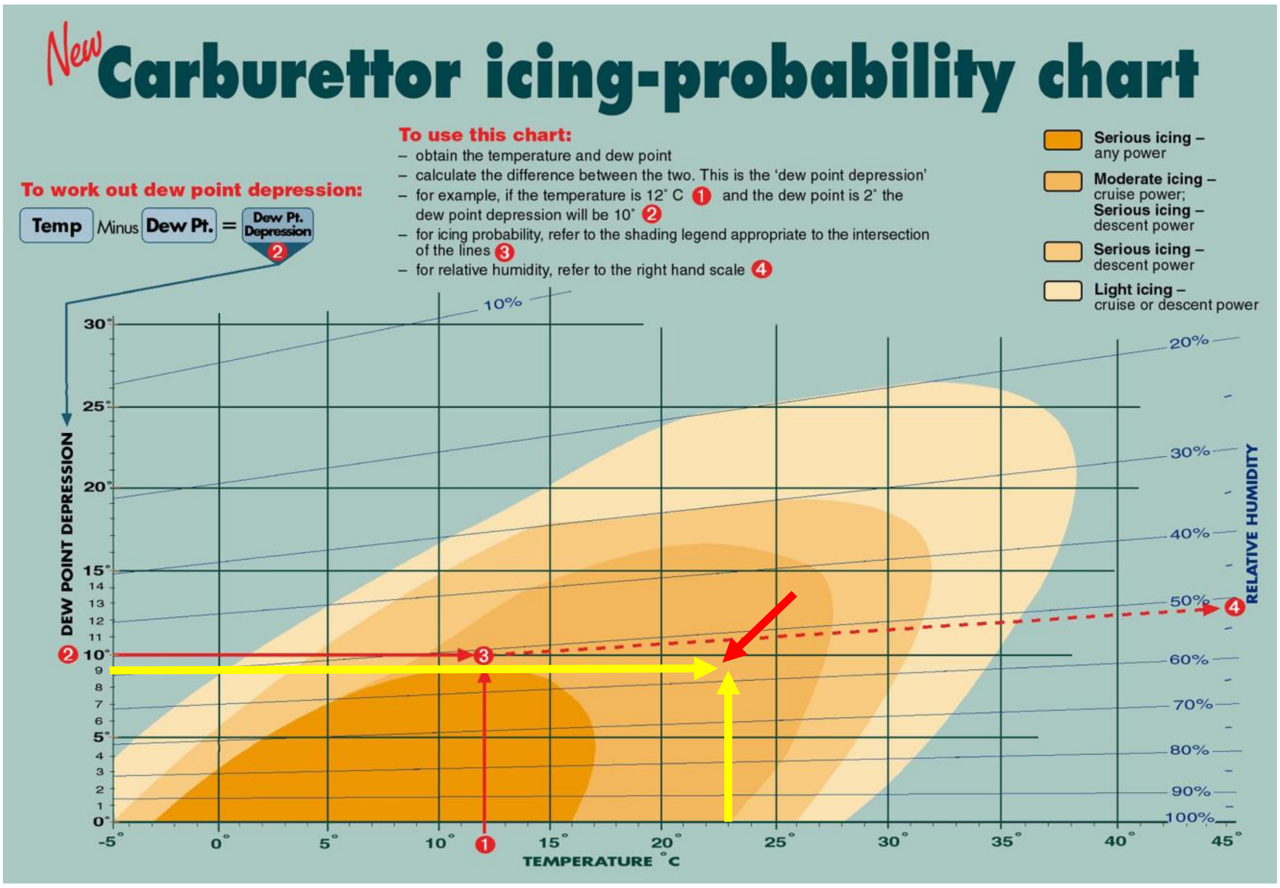

Figure 5: The yellow and red arrows indicate the probability of icing.

Carburettor Icing

Source: FAA Pilot's Handbook of Aeronautical Knowledge (25B), pages 171 and 172

One disadvantage of the float-type carburettor is its icing tendency. Carburettor ice occurs due to the effect of fuel vaporisation and the decrease in air pressure in the venturi, which causes a sharp temperature drop in the carburettor. If water vapor in the air condenses when the carburettor temperature is at or below freezing, ice may form on internal surfaces of the carburettor, including the throttle valve.

The reduced air pressure, as well as the vaporization of fuel, contributes to the temperature decrease in the carburettor. Ice generally forms in the vicinity of the throttle valve and in the venturi throat. This restricts the flow of the fuel-air mixture and reduces power. If enough ice builds up, the engine may cease to operate. Carburettor ice is most likely to occur when temperatures are below 70°F or 21°C and the relative humidity is above 80%. Due to the sudden cooling that takes place in the carburettor, icing can occur even in outside air temperatures as high as 100°F (38°C) and humidity as low as 50%. This temperature drop can be as much as 60°F to 70°F. (Remember there are 180°F from freezing to boiling versus 100°C). Therefore, an outside air temperature of 100°F (38°C), a temperature drop of an absolute 70°F (21°C) results in an air temperature in the carburettor of 30°F (-1°C). [Figure 6] The first indication of carburettor icing in an aircraft with a fixed-

pitch propeller is a decrease in engine rpm, which may be followed by engine roughness. In an aircraft with a constant-speed propeller, carburettor icing is usually indicated by a decrease in manifold pressure, but no reduction in rpm. Propeller pitch is automatically adjusted to compensate for loss of power. Thus, a constant rpm is maintained. Although carburettor ice can occur during any phase of flight, it is particularly dangerous when using reduced power during a descent. Under certain conditions, carburettor ice could build unnoticed until power is added. To combat the effects of carburettor ice, engines with float-type carburettors employ a carburettor heat system.

Carburettor Heat

Carburettor heat is an anti-icing system that preheats the air before it reaches the carburettor and is intended to keep the fuel-air mixture above freezing to prevent the formation of carburettor ice. Carburettor heat can be used to melt ice that has already formed in the carburettor if the accumulation is not too great but using carburettor heat as a preventative measure is the better option. Additionally, carburettor heat may be used as an alternate air source if the intake filter clogs, such as in sudden or unexpected airframe icing conditions. The carburettor heat should be checked during the engine runup. When using carburettor heat, follow the manufacturer's recommendations. When conditions are conducive to carburettor icing during flight, periodic checks should be made to detect its presence. If detected, full carburettor heat should be applied immediately, and it should be left in the ON position until the pilot is certain that all the ice has been removed. If ice is present, applying partial heat or leaving heat on for an insufficient time might aggravate the situation. In extreme cases of carburettor icing, even after the ice has been removed, full carburettor heat should be used to prevent further ice formation. If installed, a carburettor temperature gauge is useful in determining when to use carburettor heat.

The use of carburettor heat causes a decrease in engine power, sometimes up to 15%, because the heated air is less dense than the outside air that had been entering the engine. This enriches the mixture. When ice is present in an aircraft with a fixed-pitch propeller and carburettor heat is being used, there is a decrease in rpm, followed by a gradual increase in rpm as the ice melts. The engine also should run more smoothly after the ice has been removed. If ice is not present, the rpm decreases and then remains constant. When carburettor heat is used on an aircraft with a constant-speed propeller and ice is present, a decrease in the manifold pressure is noticed, followed by a gradual increase. If carburettor icing is not present, the gradual increase in manifold pressure is not apparent until the carburettor heat is turned off.

It is imperative for a pilot to recognize carburettor ice when it forms during flight to prevent a loss in power, altitude, and/or airspeed. These symptoms may sometimes be accompanied by vibration or engine roughness. Once a power loss is noticed, immediate action should be taken to eliminate ice already formed in the carburettor and to prevent further ice formation. This is accomplished by applying full carburettor heat, which will further reduce power and may cause engine roughness as melted ice goes through the engine. These symptoms may last from 30 seconds to several minutes, *depending on the severity of the icing. During this period, the pilot must resist the temptation to decrease the carburettor heat usage. Carburettor heat must remain in the full-hot position until normal power returns.*

Since the use of carburettor heat tends to reduce the output of the engine and to increase the operating temperature, carburettor heat should not be used when full power is required (as during take-off) or during normal engine operation, except to check for the presence of, or to remove, carburettor ice.

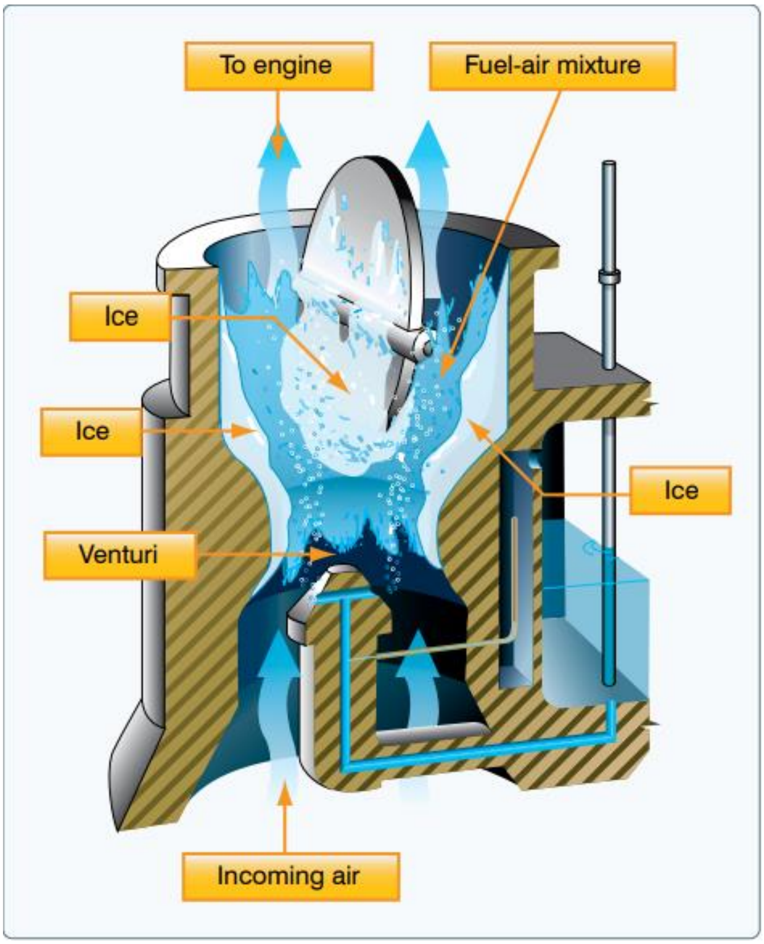

Figure 6: The formation of carburettor ice may reduce or block fuel air-flow to the engine.

<u>Follow up investigation</u>

The aircraft was recovered to an aircraft maintenance organisation (AMO) where the engine was cleaned, and the propeller was removed and a loaner propeller (similar type that was installed on the aircraft) was fitted. A loaner nose gear was also fitted after the damaged gear was removed. On Wednesday, 2 March 2022, the aircraft was prepared and secured to perform an engine ground run in the presence of the investigator. The engine started on the first attempt and was allowed to warm up before the pilot advanced the throttle to maximum revolutions per minute (RPM) through stages. The photograph below (Figure 7) was taken during the engine ground run.

Figure 7: An engine ground run was performed, and the engine ran without a problem.

During the on-site investigation, it was noted that the carburettor heat lever was in the forward position (COLD) as seen in Figure 8.

Figure 8: The position of the carburettor heat lever (in the yellow window) taken on-site.

<u>What was found</u>

(i) The student pilot was issued a Student Pilot Licence, and he had the aircraft type endorsed on it.

(ii) This was a training flight conducted under the provisions of Part 141 of the Civil Aviation Regulations 2011 as amended.

(iii) The duration of the solo navigation flight was 3.5 hours, this included the time from startup, pilot obtaining taxi clearance and take-off clearance from ATC at FALA. The flight was duly authorised by a flight instructor from the ATO.

(iv) The student pilot was the sole occupant on-board; weight and balance was not compromised.

(v) The student pilot stated that the engine ran rough and subsequently stopped while he was on approach for landing Runway 07. He attempted an engine restart but was unsuccessful.

(vi) The student pilot informed ATC that the engine had stopped; *"I have engine failure, FIF".* Following confirmation of the accident by the crew flying ZS-OHK, ATC activated the crash alarm, whereupon ARFF personnel responded to the scene.

(vii) The student pilot suffered lacerations to his face caused by the portable fire extinguisher that detached from its mounting bracket as the aircraft nosed over; he also strained his left shoulder. The student pilot was taken to the hospital. The student pilot had made use of the aircraft's safety harness, which included a shoulder harness.

(viii) The last maintenance inspection that was carried out on the aircraft prior to the accident flight was certified on 14 February 2022 at 12 623.9 airframe hours. A further 33.9 hours were flown since the inspection.

(ix) The aircraft was issued a Certificate of Airworthiness on 25 May 2017 with an expiry date of 31 May 2022.

(x) There was enough fuel on-board the aircraft with 45 litres drained after the accident.

(xi) According to the carburettor icing-probability chart, serious icing conditions prevailed during the descent phase of the aircraft. The carburettor heat lever was found in the forward position (COLD), it is highly probable that the engine stoppage was due to carburettor icing.

(xii) An engine ground test run was performed following recovery of the aircraft and no mechanical anomalies were noted that could have caused the engine to stop in operation during flight.

Probable cause:

The aircraft collided with a concealed embankment during a forced landing on an open field following an engine stoppage in-flight that was attributed to carburettor icing.

Safety Action

None.

Safety Recommendation/Message

It is recommended that all portable fire extinguishers that are positioned in either the cockpit or cabin area of an aircraft be wire-locked with copper locking wire after being secured in their respective brackets.

Pilots should be alert and know that carburettor ice could occur at any stage during flight, even in the hottest months of the year.

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

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, no 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 brief report. The report has been compiled using information supplied in the initial *notification, as well as follow-up information 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 accident.*

This report provides an opportunity to share safety message/s in the absence of an investigation.

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

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This report is issued by:

Accident and Incident Investigations Division

South African Civil Aviation Authority

Republic of South Africa