CIVIL AVIATION AUTHORITY
OF NEW ZEALAND
Te Mana Rererangi Tūmatanui o Aotearoa

CAA OCCURRENCE 22/554

Sonex Aircraft LLC Waiex

ZK-YEX

ENGINE POWER LOSS AND LOSS OF CONTROL AFTER TAKE-OFF

STRATFORD AERODROME

7 FEBRUARY 2023

Photo: Courtesy of nzcivair.blogspot.com and Richard Currie.

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Glossary of abbreviations:

BFR	biennial flight review
C	Celsius
CAA	Civil Aviation Authority
CAR	civil aviation rules
CFI	chief flight instructor
E	east
ELT	emergency locator transmitter
IA	inspection authorisation
m	metre(s)
PPL(A)	private pilot licence (Aeroplane)
RAANZ	Recreational Aircraft Association of New Zealand
RPM	revolutions per minute
S	south
s/n	serial number
UTC	Coordinated Universal Time

Data summary

Aircraft type, serial number and registration:	Sonex Aircraft LLC Waiex, s/n 155, ZK-YEX
Number and type of engines:	One, Jabiru 3300
Year of manufacture:	2013
Date and time of accident:	7 February 2023, 1140 hours[1] (approximately)
Location:	Stratford Aerodrome Latitude[2]: S 39° 19.1' Longitude: E 174° 17.8'
Type of flight:	Private
Persons on board:	Crew: 1
Injuries:	Crew: 1 (fatal)
Nature of damage:	Aircraft destroyed
Pilot-in-command's licence	Microlight Pilot Certificate
Pilot-in-command's total flying experience:	343.9 hours, 20.7 hours on type
Investigator-in-Charge:	Mr S Walker

[1] All times in this report are in New Zealand Daylight Time (UTC + 13 hours) unless otherwise specified.

[2] WGS-84 co-ordinates.

Executive summary

The pilot was on a solo flight from Stratford Aerodrome in ZK-YEX, a Sonex Aircraft LLC Waiex, which was a fixed-wing Class 2 microlight monoplane.

Shortly after the aircraft became airborne, witnesses heard the engine running roughly. The aircraft was observed to turn left back towards the aerodrome. The aircraft was seen to enter a steep nose-down attitude. This was followed by a plume of smoke coming from the vicinity. The first person on the scene found the aircraft on fire.

The engine originally installed in ZK-YEX had been recently changed to an engine type with a higher power rating. A new propeller had also been installed. The engine and propeller change had been carried out by both the pilot (who was the owner of ZK-YEX) and the chief flight instructor (CFI) of the Stratford Aero Club.

The cause of the engine power loss could not be conclusively determined.

As a result of this accident the CAA has identified the following safety message:

- Pilots should always be aware of the emergency landing options available for every take-off, in case a partial engine power loss should occur.

1. Factual information

1.1 History of the flight

1.1.1 It was reported that the pilot and CFI of the aero club intended to test fly the aircraft after the installation of a new engine and propeller.

1.1.2 The aircraft was fully fuelled. It is not known whether a preflight inspection was completed.

1.1.3 The CFI observed the take-off of the accident flight and said he heard that the engine "popped a little bit" at a height of about 100 feet. He then saw it make a left turn toward the south and observed that the nose of the aircraft did not lower as anticipated.

1.1.4 Another pilot at the aerodrome heard ZK-YEX take off and their attention was drawn to it by the engine "popping". That pilot heard the engine recover but then start running roughly at a height of between 200-300 feet. He saw the nose of the aircraft

rise slightly while ZK-YEX was flying away from the aerodrome, as if the pilot was attempting to maintain altitude. He then saw ZK-YEX make a gentle left turn back to the aerodrome maintaining the high nose angle.

1.1.5 A witness working at a nearby farm said he saw an aircraft (ZK-YEX) on climb-out from the aerodrome, heard the engine start to run roughly and then saw it turn toward the south and dive toward the ground while in the turn. This witness was very familiar with internal combustion engines and said that the engine sounded like it was "suffering from fuel starvation".

1.1.6 The witnesses saw ZK-YEX suddenly dive toward the ground and disappear out of sight. A large plume of smoke was then seen to be rising from above the location of the accident site.

1.1.7 The accident occurred in daylight, at approximately 1140 hours at Stratford, coordinates latitude S 39° 19.1', longitude E 174° 17.8', at an elevation of 970 feet.

1.2 Injuries to persons

Injuries	*Crew*	*Passengers*	*Other*
Fatal	1	0	0
Serious	0	0	0
Minor/None	0	0	

Table 1: Injuries to persons.

1.3 Damage to aircraft

1.3.1 The aircraft was destroyed.

1.4 Personnel information

Flying hours	All types	Relevant Type
Last 24 hours	0	0
Last 7 days	0.5	0
Last 30 days	1.7	0
Last 90 days	1.7	0
Total hours	343.9	20.7

Table 2. Pilot flight hours.

1.4.1 The pilot was the holder of a Microlight Pilot Certificate issued by the Recreational Aircraft Association of New Zealand (RAANZ) and a Private Pilot Licence (Aeroplane) issued by the CAA on 15 December 2000. The pilot held a valid RAANZ medical certificate.

1.4.2 The pilot held type ratings for various fixed-wing aircraft and had been issued the type rating for the Sonex Waiex by the CFI, on 9 September 2020.

1.4.3 The pilot's biennial flight review (BFR) was carried out by the CFI on 30 June 2021. The *RAANZ Flight Test/BFR Standards Guide*[3] includes instructor assessment criteria for engine failure after take-off.

[3] Refer to https://raanz.org.nz/wiki/uploads/Main/Flight%20Test%20Standards%20v1.pdf for the RAANZ Flight Test/BFR Standards Guide.

1.4.4 The CFI, in his capacity as a holder of a Microlight Inspection Authorisation (IA) issued by RAANZ, had assisted the pilot with the modification and maintenance of ZK-YEX.

1.5 Aircraft information

1.5.1 The construction of Sonex Aircraft LLC Waiex, serial number 155, was completed in Australia in 2013. The aircraft was imported into New Zealand by the pilot in July 2020 and first registered as ZK-YEX in New Zealand on 28 August 2020 in the microlight category.

1.5.2 ZK-YEX was a low-wing monoplane of all metal construction with a conventional fixed landing gear (tail-wheel) and a 'vee' configuration tailplane. It could accommodate two occupants in a side-by-side configuration and could be flown from either side.

1.5.3 When ZK-YEX was first registered, it was fitted with an AeroVee 2.1, four-cylinder horizontally-opposed, direct-drive engine, producing 80 horsepower at 3400 revolutions per minute (RPM). ZK-YEX was fitted with a Prince two-bladed, carbon fibre 'P Tip' wood/composite anti-vortex, droop-tipped propeller.

1.5.4 On 30 September 2020, the CAA issued a non-terminating microlight aircraft flight permit for ZK-YEX. This Flight Permit specified that the AeroVee 2.1 engine was installed.

1.5.5 ZK-YEX's technical log recorded that it had flown 20.7 hours since 5 September 2020.The last flight recorded was on 26 April 2021.

1.5.6 In the period since the last recorded flight, the pilot had changed the engine type to a Jabiru 3300 Gen 4, a six-cylinder, direct-drive, air-cooled engine producing 120 horsepower at 2750 rpm. According to the CFI, this was because the pilot said the AeroVee 2.1 engine was not producing sufficient power for the intended use.

1.5.7 The engine change was performed at Stratford Aerodrome by the pilot and the CFI. The aircraft was also fitted with a new Prince propeller to conform to the additional power output of the Jabiru 3300 engine.

1.5.8 The CFI recorded the results of engine ground running tests commencing on 21 January 2023. There were no reported anomalies observed, and one record of idle mixture/speed adjustment. This testing was completed on 2 February 2023.

1.5.9 The fuel tank installed in ZK-YEX had a total fuel capacity of 62 litres and was situated forward of the instrument panel and aft of the engine bay firewall.

1.5.10 The fuel supply from the fuel tank passed through a conventional in-line shut-off valve situated in the fuel supply line at the outlet of the fuel tank sump, see figure 1. An electric fuel pump and an engine-driven, diaphragm-type fuel pump delivered the fuel to the carburettor. The location of the fuel shut-off valve is close to the pilot's legs when their feet are on the rudder pedals.

1.5.11 The handle of the fuel shut-off valve installed in ZK-YEX had been extended. The extension was designed to show a placard when in the 'off' position. This type of local modification is permitted by the civil aviation rules (CARs) for microlight aircraft. It could not be determined whether the pilot could notice the 'off' position placard without actively checking.

Figure 1. Example of Sonex Waiex fuel shut-off valve in the 'off' position. Source: Chris Madsen (2015), accessed May 2023, SonexBuilders.net

Figure 2. Fuel shut-off valve from ZK-YEX showing remnants of the handle extension, post-accident. (Note the position of the handle in the photograph does not reflect a position pre-impact). Source: CAA photo.

1.5.12 The CFI reported that the pilot tended to open and close the fuel shut-off valve using his feet, when seated in the aircraft, as it was difficult to reach the valve lever to move it by hand. The flight manual procedure for starting the engine included a check that the fuel valve is selected to 'on'. For the 'on' selection, the handle is moved forward, away from the pilot.

1.6 Meteorological information

1.6.1 The weather conditions at Stratford Aerodrome at the time of the accident were reported to be good with light winds and unlimited visibility. Weather was not a factor in the accident.

1.7 Communications

1.7.1 Radio transmissions for traffic at Stratford Aerodrome are broadcast on 124.65 megahertz and are recorded for Stratford District Council. These recordings were retrieved and transcribed.

1.7.2 At 1137:55 the pilot of ZK-YEX transmitted that he was backtracking on runway 27 and asked another pilot, who was flying in the vicinity, for a radio check.

1.7.3 At 1137:58 the other pilot responded to the pilot of ZK-YEX "loud and clear".

1.7.4 At 1141:20 the pilot of ZK-YEX broadcast, "Stratford traffic Yankee Echo Xray is rolling two seven and will be operating overhead the um airfield Stratford traffic".

1.7.5 The radio communications made by the pilot of ZK-YEX were standard radio calls normally associated with taxiing, radio check, lining up and taking off. The calls were of an expected content, pace, and inflection.

1.7.6 No emergency calls were made by the pilot of ZK-YEX.

1.8 Aerodrome information

1.8.1 Stratford Aerodrome is a non-certificated and unattended[4] aerodrome situated four kilometres northeast of Stratford township.

1.8.2 The aerodrome has an elevation of 946 feet[5]. Grass runway 27 was in use on the day of the accident and has an available take-off and landing distance of 900 metres with a right-hand circuit. The area around Stratford Aerodrome consists of open farmland.

1.9 Wreckage and impact information

1.9.1 The aircraft struck the ground on a heading of approximately 120° True, in a steep nose-down and left-wing low attitude.

1.9.2 Initially the left-wing tip struck the ground, followed by the outboard leading edge of the left wing, the nose of the aircraft, and the left main landing gear.

1.9.3 After a single rebound, the main portion of the aircraft came to rest approximately three metres from the initial point of impact. The force of the impact separated the engine and its airframe mounting structure from the aircraft, which came to rest close to the main wreckage.

1.9.4 Both tips of the propeller remained embedded in the ground at the initial point of impact.

[4] Unattended, in that no air traffic service is provided.

[5] Refer to https://www.aip.net.nz/assets/AIP/Aerodrome-Charts/Stratford-NZSD/NZSD_51.1_52.1.pdf for the current AIP aerodrome operational data.

1.9.5 An intense fire erupted, fed by the almost full tank of fuel. The fire rapidly consumed the centre fuselage, parts of the engine and cockpit area. Due to the impact forces and post-accident fire, integrity of the airframe and engine fuel systems prior to the accident could not be established.

1.9.6 No information from the flight instruments was retrievable due to the fire damage, although confirmation of flight control system continuity was established at the scene.

1.9.7 The flap position when the aircraft struck the ground could not be positively determined.

1.10 Medical and pathological information

1.10.1 Post-mortem examination revealed that the pilot died of multiple blunt trauma injuries.

1.10.2 The pilot was reported to be in good spirits and had no pre-existing condition that could have resulted in incapacitation or affected the pilot's ability to fly the aircraft.

1.10.3 Post-mortem toxicology tests were negative for the presence of drugs and alcohol in the pilot's bloodstream.

1.11 Fire

1.11.1 A significant and intense post-impact fire erupted, fed by fuel from the aircraft fuel tank. The fire consumed significant portions of the aircraft structure, engine and propeller.

1.12 Survival aspects

1.12.1 Other than the safety harness worn by the pilot, the aircraft had no other safety mechanisms available, such as a crushable structure to absorb impact loads.

1.12.2 ZK-YEX did not have an emergency location transmitter (ELT) fitted, nor was one required to be.

1.12.3 The accident was not survivable.

1.13 Tests and research

1.13.1 The Jabiru 3300 engine was examined as far as possible by specialist engineers at an engine overhaul facility. There was no defect found that could have contributed to the accident. The engine fuel and ignition systems were unable to be examined as they had been consumed by the fire.

1.14 Additional information

1.14.1 The RAANZ training manual, which is published on the RAANZ website[6], includes guidance for members on engine failure during climb-out:

> *There may be enough runway left to land ahead, otherwise make a landing further ahead. Should the failure occur further in the climb there is little or no prospect of returning to the airfield because:*
>
> *Considerable height is needed to complete the 180° turn back. In haste the pilot could easily stall the microlight. Also, the groundspeed at touchdown will be higher with any tailwind component.*
>
> *Having taken off into a headwind you are better off to land ahead into wind, even on a rough surface, because the touchdown groundspeed will be lower.*

1.14.2 The CAA *Flight Instructor Guide*, published on the CAA website[7], includes advice on actions to be taken in the event of partial power loss:

> ***Partial power***
>
> *At the completion of the trouble checks, a check for partial power is made by opening the throttle to full power. If there is no response, the throttle is closed and the forced landing without power continued.*
>
> *However, If some power is available, for example, 1800 RPM at full throttle, a range of choices become available. These will require the application of aeronautical decision making and pilot judgement.*
>
> *The first decision to be made is whether to continue with the forced landing by closing the throttle, leaving the engine at idle and not relying on the available power. The alternative is to use the available power to transit to a more suitable landing site. This decision must be made with the knowledge that a partial power failure may become a total power failure at any time.*
>
> *If the decision is made to close the throttle, partial power may be available if required on final approach – but of course, cannot be relied on.*

[6] Refer to https://raanz.org.nz/wiki/pmwiki.php?n=TM.Airmanship for the relevant chapter of the RAANZ training manual.

[7] Refer to https://www.aviation.govt.nz/licensing-and-certification/pilots/flight-training/flight-instructor-guide/forced-landing-without-power-considerations for the relevant section of the CAA *Flight Instructor Guide*.

Other factors that will affect the decision are:

- *The effect of wind.*
- *The suitability of the nearest landing site.*
- *The amount of power available. For example, is there sufficient to fly level at not less than the endurance speed or is a gradual descent required to maintain airspeed?*
- *The type and height of terrain to be crossed in transiting to a more suitable landing site. For example, will flight over a built-up area be required, or can leapfrogging from landing site to landing site be accomplished?*
- *The cause of the power reduction (if known). For example, no oil pressure and reduced power can quickly become a total power failure.*
- *The aeroplane's altitude. Never fly lower than you must.*

1.14.3 The Australian Transport Safety Bureau published safety information relating to partial power loss after take-off, in the form of Booklet *No. AR-2010-055 Avoidable Accidents #3, Managing partial power loss after takeoff in single engine aircraft*[8]. The aim of the booklet is to increase awareness among flying instructors and pilots of the issues relating to partial power loss after take-off in single-engine aircraft.

The key messages in the booklet are:

Most fatal and serious injury accidents resulting from partial power loss after takeoff are avoidable. This booklet will show that you can prevent or significantly minimise the risk of bodily harm following a partial or complete engine power loss after takeoff by using the strategies below:

- *pre-flight decision making and planning for emergencies and abnormal situations for the particular aerodrome*
- *conducting a thorough pre-flight and engine ground run to reduce the risk of a partial power loss occurring*
- *taking positive action and maintaining aircraft control either when turning back to the aerodrome or conducting a forced landing until on the ground, while being aware of flare energy and aircraft stall speeds.*

1.14.4 The version of the Sonex Waiex flight manual carried onboard ZK-YEX contained procedures regarding 'engine roughness' in the emergency procedures section. The procedures stated, should engine roughness be experienced, the pilot should head to the nearest airfield for repairs.

[8] Refer to: https://www.atsb.gov.au/publications/2010/avoidable-3-ar-2010-055.

2. Analysis

2.1 As far as could be established, there was no evidence of any pre-existing mechanical discrepancy with the aircraft or its new engine.

2.2 The propeller tips appeared to have broken away from the propeller by the impact rather than the propeller having been shattered by striking the ground while under power. This shows that the engine was most likely not producing any power at the time the aircraft struck the ground.

2.3 The information gained from the witnesses regarding the sounds made by the engine and the nature of the final turn suggested a partial power loss in flight

2.4 It is likely that the engine power loss was related to some interruption or starvation of the fuel supply to the engine. This could not be positively determined due to the damage to the aircraft from the post impact fire.

2.5 Possible reasons for in flight fuel starvation include unintended interference with the fuel shut off valve, a blockage in the engine fuel system including the fuel pump, a blockage in the airframe fuel system, a blockage in the fuel tank vent. None of these possibilities could be positively determined as being a factor in the accident, due to the aircraft being consumed by fire.

2.6 It is likely that, faced with a rough-running engine and partial loss of power at a height of 200-300 feet, the pilot decided to attempt a return to the aerodrome and initiated a left turn against the published circuit direction. There was an option available to the pilot to conduct an emergency landing straight ahead, see figure 3.

2.7 It is notable that the pilot kept the nose of the aircraft high, before and during the initiation of the turn. This was probably an attempt to maintain altitude to increase the likelihood of reaching the runway. In doing so, this decreased the stall margin, which increased the risk of an aerodynamic stall.

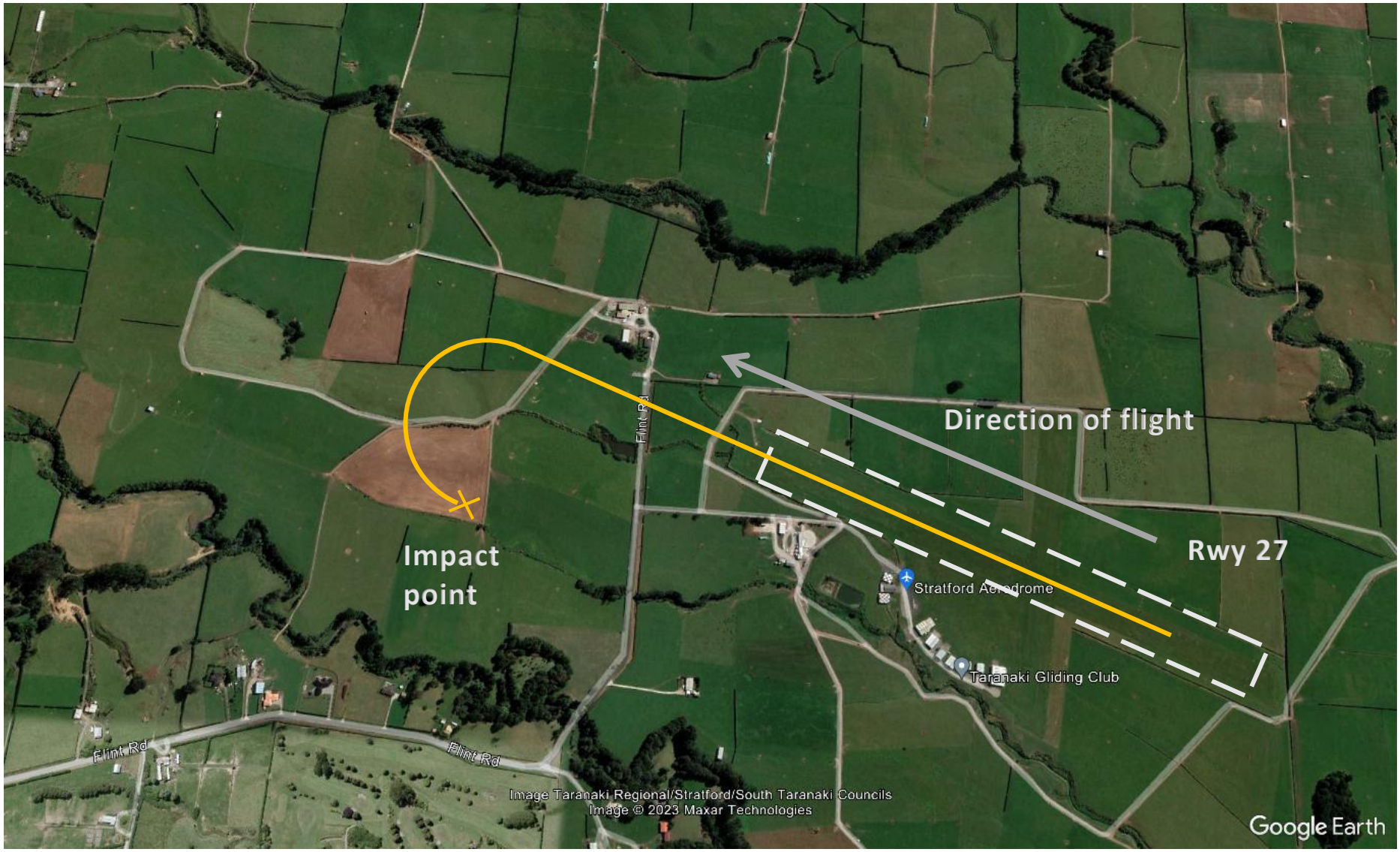

Figure 3. Stratford Aerodrome and approximate flight path of ZK-YEX

2.8 Performing a turnback to an aerodrome at low level, with minimal engine power and low airspeed, is a challenge for any pilot. At some point during the turnback an aerodynamic stall probably occurred, resulting in a loss of control and collision with terrain.

3. Conclusions

3.1 The pilot was appropriately licensed, experienced, and fit to carry out the flight.

3.2 There was no evidence found of any discrepancy related to the aircraft or its engine that could have contributed to the accident.

3.3 It is likely that fuel starvation caused the engine power loss.

3.4 It was not possible to say with certainty why the accident occurred however, the pilot probably elected to return to the aerodrome and during the turnback an aerodynamic stall probably occurred from which the pilot was unable to recover in the height available.

4. Safety message

4.1 Pilots of all aircraft types are encouraged to learn how to respond to a partial engine power loss after take-off, and consider the options available for every take-off, should a partial engine power loss occur.

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