



AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:	CA18/2/3/9952	
Aircraft Registration	ZS-XAT	Date of Accident	4 February 2021		Time of Accident	0932Z
Type of Aircraft	Air Tractor AT-502B		Type of Operation		Private (Part 91)	
Pilot-in-command Licence Type	CPL	Age	67		Licence Valid	Yes
Pilot-in-command Flying Experience	Total Flying Hours	21 932.3		Hours on Type	8560.0	
Last Point of Departure	Lanseria International Airport (FALA), Gauteng Province, South Africa					
Next Point of Intended Landing	Hosea Kutako International Airport (FYWH), Namibia					
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)						
Letsatsi Game Lodge, North West province (GPS position: 25°40'4.0" South, 026°53'7.8" East at an elevation of 4500ft)						
Damage to Aircraft	Destroyed					
Meteorological Information	Wind: 270° at 1kt; Temperature: 22°C; Dew Point: 20°C; Visibility: Unknown; Cloud: Broken at 2000-3000ft AGL; QNH: 1019 hPa					
Number of People On-board	1+0	No. of People Injured	0		No. of People Killed	1
Synopsis	<p>On 4 February 2021, two Air Tractor AT-502B aircraft with registrations ZS-XAT and ZS-XAS took off on a ferry flight from Lanseria International Airport (FALA) in Gauteng province to Hosea Kutako International Airport (FYWH) in Namibia. The flight was conducted under visual flight rules (VFR) by day.</p> <p>The pilot of ZS-XAS flew towards north of Rustenburg and turned in a south-westerly direction due to the deteriorating weather conditions. The pilot then tried to contact the ZS-XAT pilot but to no avail. He then contacted Johannesburg (JHB) Information for an update on the weather conditions. JHB Information advised him that the weather conditions were becoming more unfavourable to fly; thereafter, the ZS-XAS pilot made a decision to fly back to FALA.</p> <p>The last known position of ZS-XAT was abeam Morningside Airfield (FAMS) as per the operator's tracking device. An eyewitness stated that he saw the aircraft emerging from the clouds in a descending path, and a few seconds later, it disappeared from his line of sight. Thereafter, he heard a loud bang and saw smoke coming from the direction at which he lost sight of the aircraft. Other eyewitnesses located the wreckage and notified the local fire-fighters that an aircraft was on fire. They then discovered that the pilot was trapped in the wreckage, and that he had succumbed to his injuries on impact.</p> <p>The pilot was fatally injured during the accident sequence, and the aircraft was destroyed due to impact and a post-impact fire.</p>					
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Probable Cause and/or Contributory Factors

It is probable that once the pilot had entered an area of little to no visibility, he became spatially disorientated and lost control of the aircraft. The aircraft then descended in a left spiral with a high degree of disintegration before impacting the ground.

Contributing factor:

Inadequate flight planning.

Improper VFR into instrument meteorological conditions (IMC).

SRP Date	8 February 2022	Publication Date	11 February 2022
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ABBREVIATION	DESCRIPTION
AIID	Accident and Incident Investigations Division
AGL	Above Ground Level
AME	Aircraft Maintenance Engineer
AMO	Aircraft Maintenance Organisation
AOC	Air Operating Certificate
C	Celsius
CAR	Civil Aviation Regulations
CVR	Cockpit Voice Recorder
CofA	Certificate of Airworthiness
CofR	Certificate of Registration
CRS	Certificate of Release to Service
CT	Compressor Turbine
FARG	Rustenburg Airfield
FALA	Lanseria International Airport
FAMM	Mmabatho International Airport
FAMS	Morningside Farm Airfield
FCU	Fuel Control Unit
FDR	Flight Data Recorder
FM	Flight Manual
FOHE	Fuel oil heat exchange
FT	Feet
FYWH	Hosea Kutako International Airport
GPS	Global Positioning System
hPa	Hectopascal
IMC	Instrument Meteorological Conditions
km	Kilometre
Kts	Knots
L	Litre
m	Metre
METAR	Meteorological Aerodrome Report
MPI	Mandatory Periodic Inspection
ml	Millilitre
n/a	Not Applicable
nm	Nautical Mile
PT	Power Turbine
QNH	Query Nautical Height
SACAA	South African Civil Aviation Authority
UTC	Co-ordinated Universal Time
VEMD	Vehicle and Engine Monitoring Device
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
NVE	Never Exceed Speed
VOR	Very High Frequency Omni-directional Range
Z	Zulu

Reference Number : CA18/2/3/9952
Name of Owner/Operator : Xcalibur Resources (PTY) LTD
Manufacturer : Air Tractor Inc
Model : AT-502B
Nationality : South African
Registration markings : ZS-XAT
Place : Millvale, North West province
Date : 4 February 2021
Time : 0932Z

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 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.***

Investigation Process:

The accident was notified to the Accident and Incident Investigations Division (AIID) on 4 February 2021 and the investigators dispatched to the site on the same day. The investigators co-ordinated with all authorities on site by initiating the accident investigation process according to CAR Part 12 and investigation procedures. Notifications were sent to the National Transportation Safety Board (NTSB) and the Transportation Safety Board of Canada (TSB), which nominated non-travelling accredited representatives, respectively. The AIID, a division within the South African Civil Aviation Authority (SACAA), is leading the investigation as the Republic of South Africa is the state of occurrence.

Notes:

1. *Whenever the following words are mentioned in this report, they shall mean the following:*

- *Accident – this investigated accident*
- *Aircraft – the Air Tractor AT-502B involved in this accident*
- *Investigation – the investigation into the circumstances of this accident*
- *Pilot – the pilot involved in this accident*
- *Report – this accident report*

2. *Photos and figures used in this report were taken from different sources and may be adjusted from the original for the sole purpose of improving clarity of the report. Modifications to images used in this report are limited to cropping, magnification, file compression; or enhancement of colour, brightness, contrast; or addition of text boxes, arrows or lines.*

Disclaimer:

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1. FACTUAL INFORMATION

1.1. History of Flight

1.1.1 On 4 February 2021, two AT-502B aircraft with registrations ZS-XAT and ZS-XAS took off from Lanseria International Airport (FALA) in Gauteng province on ferry flights to Hosea Kutako International Airport (FYWH) in Namibia. The flights were conducted under visual flight rules (VFR) by day and under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended.

1.1.2 The pilot of ZS-XAS stated that he took off at 0858Z after ZS-XAT aircraft. The two pilots were communicating via very high frequency (VHF) radio during the flight. He (ZS-XAS pilot) then routed right (see Figure 1 blue line) of the planned flight path due to low-hanging clouds; and climbed to flight level 055 (FL055). He then contacted the ZS-XAT pilot, who responded and notified him that he was climbing to FL100 and was flying to the left (see Figure 1 red line) of the planned flight path. The pilot of the ZS-XAS flew towards north of Rustenburg and turned in a south-westerly direction due to deteriorating weather conditions. He then tried to contact the ZS-XAT pilot but to no avail. Thereafter, he contacted Johannesburg (JHB) Information to get an update on the weather conditions. JHB Information advised him that the weather conditions were becoming more unfavourable to fly; thereafter, the ZS-XAS pilot made the decision to fly back to FALA.

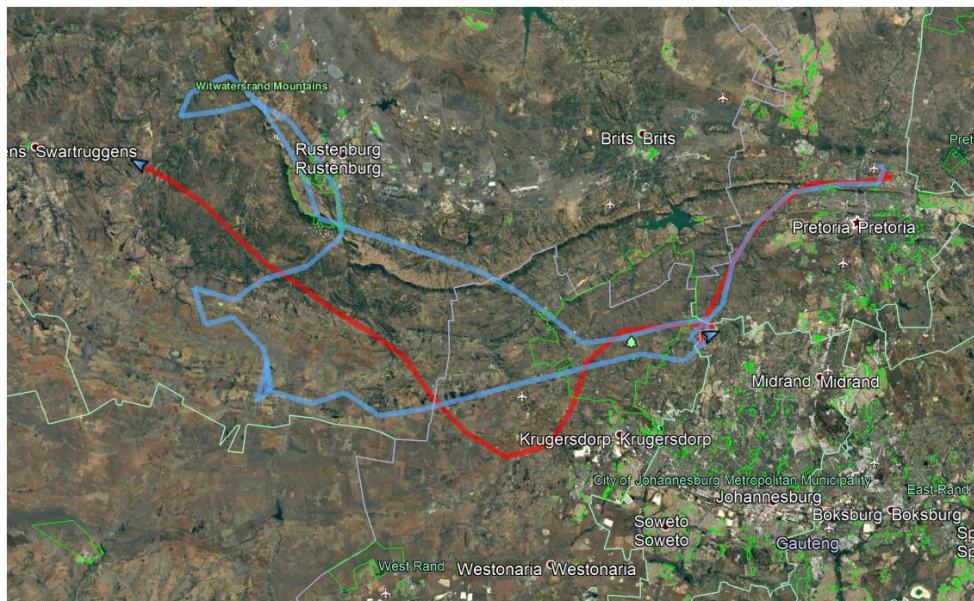


Figure 1: The flight paths of both aircraft — red line is ZS-XAT path, and blue line is ZS-XAS path.
(Source: Operator)

1.1.3 Both aircraft had tracking devices installed. The operator, based at Wonderboom Airport (FAWB), was tracking both aircraft. Figure 2 shows the flight path of the ZS-XAT aircraft:

1.1.3.1 The red shaded area relates to the altitude of the accident aircraft (ZS-XAT). The aircraft took off from FAWB and made a descent to FALA where it landed without event. The purpose of landing at Lanseria was to clear immigration and customs before proceeding to Namibia. The aircraft then took off again routing to FYWH; it climbed to 6000 feet (ft) above mean sea level (AMSL) approximately 50 miles from FALA; it again climbed to an altitude of 10 344ft AMSL at 0932Z when it disappeared from the tracking device.

- 1.1.3.2 The blue shaded area (in Figure 2) relates to the speed of the aircraft (ZS-XAT). The aircraft took off from FAWB and made a descent to FALA where it landed without event. It then took off again and climbed, reaching a speed of 165 miles per hour (mph) or 143 knots (kts) approximately 50 miles from FALA. Thereafter, the speed started to decrease until 117mph (101kts) at 0930Z before the aircraft disappeared from the tracking device.
- 1.1.3.3 The point where the aircraft disappeared from the operator's tracking device and radar control of JHB Information was determined to be 1 nautical mile (nm) north-east of Morningside Airfield (FAMS).

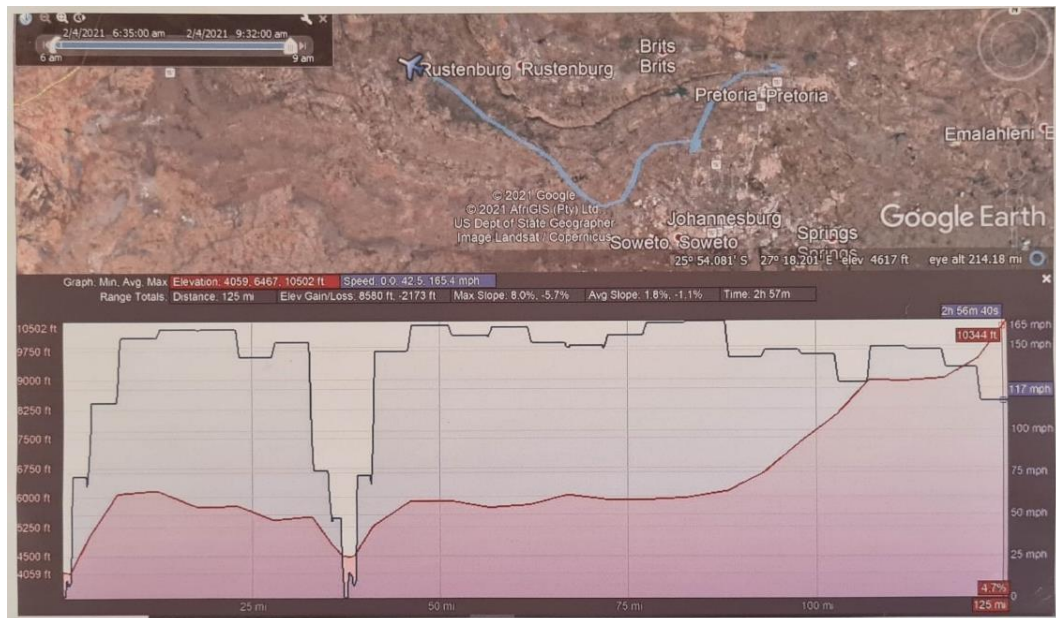


Figure 2: The flight path of the ZS-XAT aircraft. (Source: Operator)

- 1.1.4 According to an eyewitness (farmer) who was working at a farm approximately 2.8 kilometres (km) south-east of the accident site, the aircraft was flying from the north-east direction and descended below the low clouds. The aircraft then turned right and disappeared from his view. From the sound of the aircraft's engine, it seemed as though it was speeding. A few seconds later, the aircraft's engine went quiet but soon after, the eyewitness heard a loud bang. The eyewitness had, earlier that morning, noted that the clouds were very low and that he could not see the peaks of the surrounding hills. The manager at the game farm where the accident occurred stated that she heard the loud bang and she, together with the farm workers, went towards the direction from where the smoke was coming from. They located the wreckage and notified the local fire-fighters that the aircraft was on fire. They then discovered that the pilot was trapped in the wreckage and had succumbed to his injuries as a result of impact forces.
- 1.1.5 The aircraft had an in-flight break up and subsequently impacted the ground. The aircraft was destroyed by impact forces as well as a post-impact fire.
- 1.1.6 The accident occurred during day light at Letsatsi Game Lodge in the North West province at Global Positioning System (GPS) co-ordinates determined to be: 25°40'4.0" South 026°53'7.8" East, at an elevation of 4500 feet (ft).

1.2. Injuries to Persons

Injuries	Pilot	Crew	Pass.	Total On-board	Other
Fatal	1	-	-	1	-
Serious	-	-	-	-	-
Minor	-	-	-	-	-
None	-	-	-	-	-
Total	1	-	-	1	-

Note: Other means people on ground.

1.3. Damage to Aircraft

1.3.1 The aircraft was destroyed by impact forces and a post-impact fire during the accident sequence.



Figure 3: The aircraft at the accident site.

1.4. Other Damage

1.4.1 Some trees in proximity to the accident site were burnt during post-impact fire.

1.5. Personnel Information

Nationality	South African	Gender	Male	Age	67
Licence Number	0270022155	Licence Type	CPL (Aeroplane)		
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Night, Instructor Grade 3, Agricultural, Test Pilot Class 2				
Medical Expiry Date	31 July 2021				
Restrictions	Suitable Corrective Lenses				
Previous Accidents	None.				

Note: Previous accidents refer to past accidents the pilot was involved in, when relevant to this accident.

- 1.5.1 The pilot was issued a Commercial Pilot Licence (Aeroplane) on 3 February 2021 with an expiry date of 31 March 2022. The aircraft type was endorsed on his licence. The pilot was not issued an instrument flight rating.
- 1.5.2 The investigators were unable to locate the pilot's logbook at the time of completing this report. The table below shows a summary of the pilot's total flight hours until 23 January 2021, including the flight of 4 February 2021. The hours were obtained from the logbook copies found in the pilot's file at the South African Civil Aviation Authority's (SACAA's) facility which were submitted for the pilot's annual licence renewal.

Flying Experience:

Total Hours	21 932.3
Total Past 24 Hours	2.8
Total Past 7 Days	2.8
Total Past 90 Days	54.4
Total on Type Past 90 Days	48.2
Total on Type	8560.0

1.6. Aircraft Information

Extract from the Air Tractor AT-502 Airplane Flight Manual Supplement:

The Air Tractor AT-502B is an all metal cantilever low wing monoplane designed specifically for the agricultural purpose. It is a single seater equipped with one Pratt and Whitney (P&W) PT6A-34AG turbo prop engine. Its landing gear configuration tricycle consist of two fixed main landing gear combination of a tail dragger wheel gear. The aircraft's propeller is a constant speed, three bladed type fitted with a governor with reversible and feathering ability. The fuel system consists of wet wing tanks ranging between 120-290 gallons each. A 400 gallons single piece fibreglass hopper is equipped with an emergency dump gate controlled through a lever in the cockpit. The cockpit has a warning placard which reads: "A stall during skidding turns will cause the nose to pitch down sharply and result in a significant loss of altitude".

Airframe:

Manufacturer/Model	Air Tractor AT-502B	
Serial Number	502B-2968	
Year of Manufacture	2014	
Total Airframe Hours (At Time of Accident)	3 762.0	
Last MPI (Date & Hours)	20 January 2021	3759.2
Hours Since Last MPI	2.8	
C of A (Issue Date)	15 November 2014	
C of A (Expiry Date)	30 November 2021	
C of R (Issue Date) (Present Owner)	18 September 2014	
Type of Fuel Used in the Aircraft	Jet A1	
Operating Categories	Standard Part 91	
Previous Accidents	None	

Note: Previous accidents refer to past accidents the aircraft was involved in, when relevant to this accident.

1.6.1 An extract from the Pilot's Operating Handbook (POH):

1.2 AIRSPEED LIMITATIONS:

<u>SPEED (MPH)</u>	<u>CAS</u>	<u>IAS</u>	<u>REMARKS</u>
Maneuver (V_a)	140	138	No full or abrupt control movements above this speed.
Maximum Flap Extended (V_{fe})	115	118	Do not exceed with fully extended flaps.
Maximum Structural Cruising (V_{no})	140	138	Do not exceed in turbulent air.
Never Exceed (V_{ne})	155	153	Do not exceed in any operation

1.6.2 The aircraft manufacturer was given different locations of the separated aircraft parts together with the approximate time of the start of descent until the approximate time of impact. The calculated airspeed based on the provided data is as follows:

9:29:30 to 9:32:29 (2 min, 59 sec):	49 mph
9:30:00 to 9:32:00 (2 min):	74 mph
9:30:29 to 9:31:30 (1 min 1 sec):	145 mph

(all of these round-up to 9:30 to 9:32)

Engine:

Manufacturer/Model	P&W, PT6A-34AG
Serial Number	PCE-PH1003
Hours Since New	3762.0
Hours Since Overhaul	TBO not reached

Propeller:

Manufacturer/Model	Hartzell HC0-B3TN-3D
Serial Number	BUA32947
Hours Since New	3762.0
Hours Since Overhaul	1185.7

1.6.3 The last maintenance inspection carried out on the aircraft prior to the accident flight was on 20 January 2021 at 3759.2 airframe hours. The aircraft was issued a Certificate of Release to Service (CRS) on 20 January 2021 with an expiry date of 19 January 2022 or at 3909.2 hours, whichever occurs first.

1.7. Meteorological Information

1.7.1 A weather report for 4 February 2021 at 0900Z was obtained from the meteorological aerodrome reports (METARs) which were made available for the closest weather station, which is Rustenburg Airfield (FARG).

Wind Direction	270°	Wind Speed	1 knot	Visibility	unknown
Temperature	22°C	Cloud Cover	Broken	Cloud Base	2000-3000ft
Dew Point	20°C	QNH	1019hPa		

1.7.2 ATTACHMENT C Sigwx chart valid 04/02/2021 at 0900Z (from the South African Weather Service)

Red area is roughly the accident site.

It shows generally cloudy area with low level stratocumulus and cumulus clouds ranging from 1500-3000ft above ground with tops up to 12000ft and also towering cumulus clouds which could have some light showery rain.

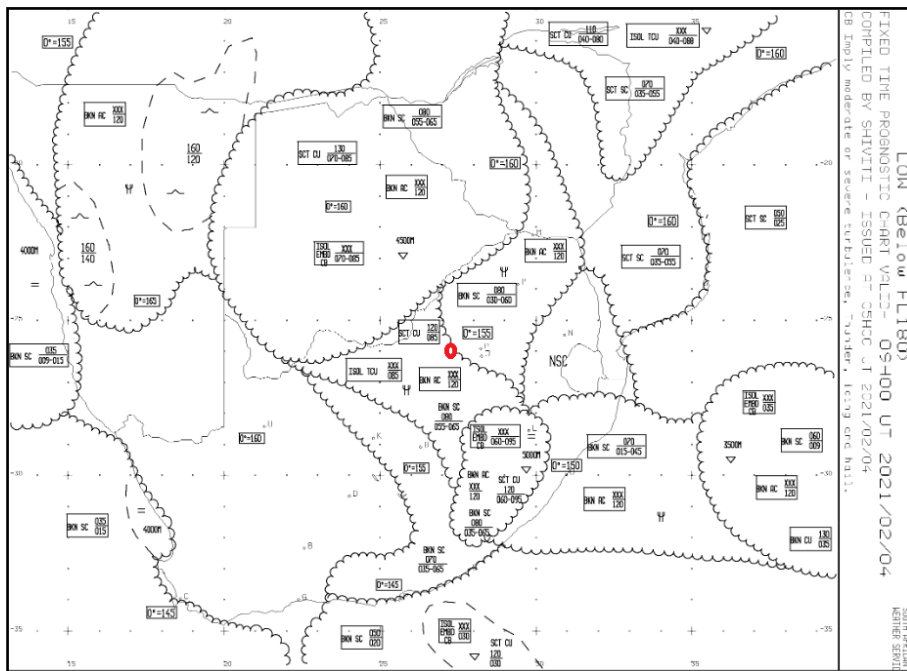


Figure 4: The cloud bases and tops at the time of the accident.

1.7.3 The weather report of 4 February 2021 shows that the weather stations along the planned route — FALA, Hartbeespoort, Buffelspoort, FARG and FAMM recorded broken cumulus at 2000-4000ft above ground level (AGL) with cumulonimbus clouds, towering cumulus at 4500ft AGL, and overcast at 6000ft AGL. The grey cross in Figure 5 represents the accident site.

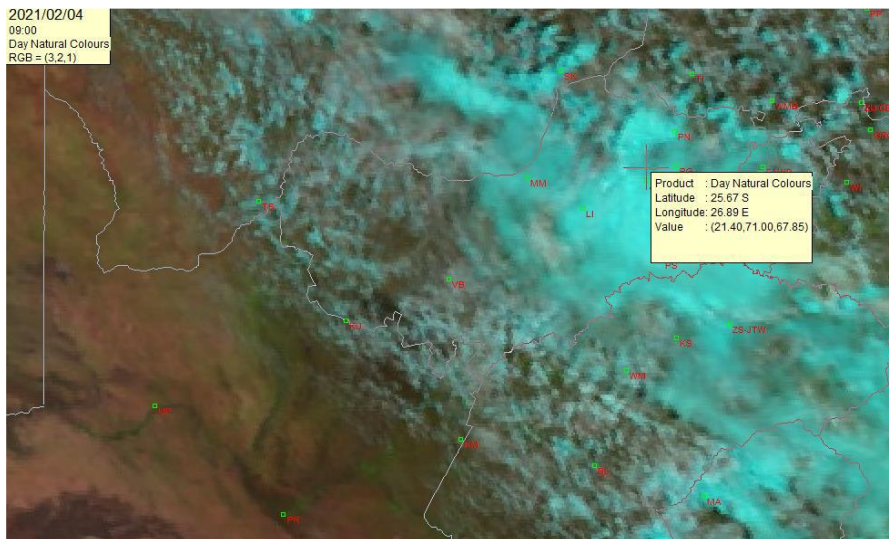


Figure 5: The cloud cover at the time of accident.

1.7.4 According to the flight plan, the flight was conducted under visual flight rules (VFR).

1.7.5 CAR 2011 Part 91.06.21 Visual Flight Rules

A VFR flight shall be conducted so that the aircraft is flown: (a) With visual reference to the surface by day and to identifiable objects by night and at no time above more than three eighths of cloud within a radius of 5 NM of the aircraft in flight.

1.8. Aids to Navigation

1.8.1 The aircraft was equipped with standard navigational equipment as approved by the Regulator (SACAA). There were no recorded defects with the navigational equipment prior to the flight.

1.9. Communication

1.9.1 The aircraft was equipped with standard communication equipment as approved by the Regulator. No defects that could render the communication system unserviceable were recorded before the flight. The pilot was communicating with the ZS-XAS pilot on 124.8-Megahertz (MHz) frequency until a few minutes before the accident occurred.

1.10. Aerodrome Information

1.10.1 The accident occurred during day light at Letsatsi Game Lodge in Millvale North West province at GPS co-ordinates determined to be: 25°40'4.0" South 026°53'7.8" East, at an elevation of 4500ft. Morningside Airfield is the nearest aerodrome to the accident site.

Aerodrome Location	Morningside Airfield (FAMS)
Aerodrome Status: Registered	Private
Aerodrome Co-ordinates	25°41'59" South, 026°54'45" East
Aerodrome Altitude	4251ft
Runway Headings	03/21
Runway Dimensions	1402m X 9m

Runway Used	n/a
Runway Surface	Asphalt
Approach Facilities	None
Radio Frequency	124.8-MHz

1.11. Flight Recorders

1.11.1 The aircraft was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR), nor was it required by regulation to be fitted to this aircraft type.

1.12 Wreckage and Impact Information

1.12.1 The aircraft took off from FALA and climbed to 6000ft AMSL approximately 50 miles from FALA. It further climbed to 10 000ft AMSL approximately 1nm north-east of FAMS. The aircraft was then observed making a descent below the clouds; it turned right before descending to the ground.

1.12.2 On-site inspection showed signs that the aircraft was in a high rate of descent in a steep angle. It approached from a south-easterly direction and flew in a left bank through the trees, severing the ones on its right-side path (Figure 6). The tail section folded onto the cabin section and the aircraft skidded to the left, leaving behind the severed right wing; the right stinger was still attached at impact point. A post-impact fire ensued and burnt the cabin, some parts of the left wing, engine and the trees on the left-side path (Figure 6). The black arrow (Figure 6) shows the impact direction; the red circle indicates the severed right wing; the yellow circle shows the severed undercarriage; and the orange circle indicates the rest of the aircraft.



Figure 6: The wreckage layout post-accident.

1.12.3 Parts of the left wing tip were found to the south of the main wreckage with the furthest being 1km south. The red dots (1-8) in Figure 7 represent different locations where these parts were found. The left-wing root fairing (Figure 8 top right) was located 550m south of the

wreckage. The left stinger (Figure 9) and hopper door (Figure 8 bottom right) were located 450m from the wreckage, while the right flap (Figure 8 bottom left) was located 350m south of the wreckage.

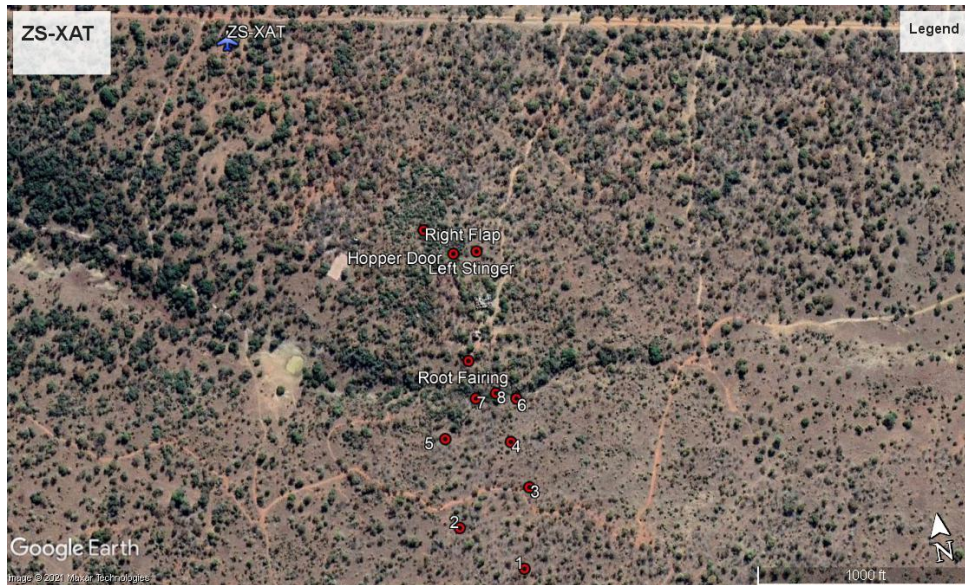


Figure 7: The wreckage distribution.



Figure 8: Parts of the left wing tip (top left), left root fairing (top right), right flap (bottom left) and hopper door (bottom right).



Figure 9: The left-wing stinger.

1.12.4 One of the left-wing aileron attachments together with a piece of left-wing main tank projected 15 metres (m) north of the wreckage when the aircraft impacted the ground.



Figure 10: The left-wing aileron attachment.

1.12.5 The engine was burnt by post-impact fire. Damage to the engine was due to impact forces.



Figure 11: The engine post-accident.

1.12.6 Two of the propeller blades were severed on impact and the third was still attached to the hub. All three blades showed signs of rotation and damage caused by impact.



Figure 12: The propeller blades showing rotation signatures on the tips.

1.13 Medical and Pathological Information

1.13.1 The pilot was fatally injured during the accident sequence. The Medico-Legal post mortem report concluded that the cause of death was due to multiple blunt force injuries during impact and burns sustained during post-impact fire.

1.14 Fire

1.14.1 Shortly after the aircraft impacted the ground, a fire ensued around the engine compartment, cabin, right landing gear tyre and left wing. Some of the trees in the surrounding area also caught fire.

1.15 Survival Aspects

1.15.1 The accident was considered unsurvivable due to the damage caused by impact and post-accident fire to the cabin and cockpit areas of the aircraft. The pilot was also trapped inside the wreckage due to the tail section folding onto the cabin section.

1.16 Tests and Research

1.16.1 Tests

Field Notes and Engine On-site Assessment: Pratt and Whitney Canada (PWC)

The engine (PT6A-34AG) field inspection was performed on 5 February 2021 by a field support manager from PWC at the accident site. This is what was observed:

External Condition

- *Engine data plate was not found in the wreckage. The engine externals were dirty and covered in environmental debris. The engine showed multiple areas with*

compressive and impact damage. The compressor rotor and propeller shaft did not rotate. The engine externals were covered in soot and ashes.

Reduction Gearbox –(RGB)

- Front reduction gearbox had cracked, exposing the internal gear sets. The propeller shaft did not rotate; the constant speed unit (CSU) was still attached to the RGB; the over speed governor mounting flange was fractured; Tachometer was attached; mounting flange, cracked.*
- The airframe exhaust stacks were compressed, buckled, deformed and damaged from impact. The exhaust case was compressed and showed impact damage. The engine C flange was separated in multiple locations.*
- The gas generator case (GGC) showed impact damage and deformation. All of the fuel nozzles were accounted for.*
- The entire accessory gearbox (AGB) and the inlet case were fractured and consumed by fire.*

Accessory Gearbox (AGB)

- Consumed by fire – the accessories were identifiable only by the burnt gears and bearings in the pile of burnt AGB material.*

Power Control Linkage and Reversing Linkage

- The cam box and associated linkages were found in the pile of AGB burnt material. The linkages were fractured and showed fire damage.*
- Fragments of the reversing cable were identified, and the CSU reset arm was attached to the CSU and fractured.*
- The Beta lever, beta valve, reversing lever guide pin showed impact damage.*

Pneumatic Lines

- Compressor Discharge Air (P3) and P3 Filter: P3 line at the fuel control unit (FCU) to the P3 air filter was consumed by fire; from the P3 filter to fire seal was consumed by fire. P3 line from the GGC to the fire seal showed impact damage but was continuous.*
- Power Turbine Control (PY): The PY line was continuous from the CSU to the fire seal by the inlet case. The PY line from the fire seal to the FCU was consumed by fire.*

Chip Detector and Filters

- Chip Detectors: AGB chip detector was found amongst the pile of burnt AGB material. The RGB chip detector was still installed on the AGB and upon removal.*
- Oil Filter: Consumed by fire along with the AGB.*
- Fuel Filter: Fuel filter was not accessed and was found in the pile of burnt material by the FCU.*

Compressor Turbine (CT) Section

- Compressor Turbine was not accessed at the site.

Combustion Section

- The combustion chamber was examined using a borescope. Impact damages and deformation were observed.

Power Turbine (PT) Section

- Borescope inspection showed several PT blades were no longer in the disc fir-trees and several PT blades were in the exhaust case (Figure 12). PT blade shrouded tips showed rubbing wear on the blade fir-tree faces and platform (Figure 13).



Figure 12: PT blades in the exhaust case.



Figure 13: PT Blade shrouded tips.

Compressor Section

- The axial compressor rotor was found next to the engine with some blades still installed on the disc. All six (6) tie rods fractured. The third stage compressor rotor was found away from the main wreckage with some blades still installed but bent.
- The axial compressor stators remained in the compressor housing and were flattened/bent. The compressor rotor shrouds showed rubbing wear. The centrifugal

impeller was visible through the compressor case and the aerofoils showed rubbing wear with deformed aerofoils.

Controls and Accessories

- *The FCU and fuel pump were fractured and partially consumed by fire. The FOHE was consumed by fire.*

1.16.2 Research

VFR Into IMC Can Lead to In-Flight Breakup (Aircraft Owners and Pilots Association)

VFR-only pilots who succumb to spatial disorientation during encounters with instrument conditions often fall prey to the so-called “graveyard spiral”—a descending turn that only gets tighter and steeper as the pilot pulls back on the yoke in a misguided attempt to stop the descent. In this scenario, ground impact is typically what destroys the airplane. But unusual attitudes can put tremendous strain on an airframe, and a panicked pilot lost in the soup can push an aircraft literally to the breaking point.

On Sept. 4, 2006, the non-instrument rated pilot of a Cessna 150 became spatially disoriented when he flew into instrument meteorological conditions (IMC) near Penhook, Va. The aircraft entered an unusual attitude so extreme that the wings were torn from the airplane in-flight. The pilot and his passenger were killed.

The reason is simple: Most non-instrument-rated pilots have only a few hours of hood time in their logbooks, and these skills quickly atrophy after the private check ride. Caught in IMC and deprived of visual references, the VFR pilot begins to rely on the body’s motion-and gravity-sensing organs—a system that is prone to illusion. In the battle of trust between instinct and instruments, the gauges typically lose. The best way to avoid a VFR-into-IMC accident is to get an instrument rating and keep it current. Short of that, the key is understanding and respecting the weather. Always get a thorough pre-flight briefing, especially if conditions along the route are questionable. And remember that water vapour is fickle: Ceilings can drop quickly, fog can materialise rapidly, and the clear air between cloud layers can close in with little warning. Give yourself plenty of wiggle room, have a Plan B set to go, and do not hesitate to divert at the first sign of trouble.

1.17 Organisational and Management Information

1.17.1 The flight was conducted under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended.

1.17.2 The operator was issued an Air Operating Certificate (AOC) number CAA/G767D with endorsement of Part 135 by the Regulator (SACAA) on 4 March 2020. The operator of the aircraft held a Class G certificate in accordance with the Civil Aviation Regulations.

1.17.3 The aircraft maintenance organisation (AMO) that certified the inspection was in possession of an AMO approval certificate issued by the SACAA on 11 August 2020 with an expiry date of 31 July 2021.

1.18 Additional Information

1.18.1 *Spatial disorientation (ATSB: An overview of spatial disorientation as a factor in aviation accidents and incidents)*

Spatial disorientation is a type of loss of situation awareness, and is different to geographical disorientation, or incorrectly perceiving the aircraft's distance or bearing from a fixed location. Spatial disorientation occurs when pilots do not correctly sense their aircraft's attitude, airspeed or altitude in relation to the earth's surface. In terms of an aircraft's attitude, spatial disorientation is often described simply as the inability to determine 'which way is up', although the effects can often be subtler than implied by that description. Spatial disorientation occurs when the brain receives conflicting or ambiguous information from the sensory systems. It is likely to happen in conditions in which visual cues are poor or absent, such as in adverse weather or at night. Spatial disorientation presents a danger to pilots, as the resulting confusion can often lead to incorrect control inputs and resultant loss of aircraft control. Research on spatial disorientation indicates that, for pilots who are not instrument rated, loss of control will likely occur between 60 seconds (Benson, 1988 in Gibb, Gray and Scharff, 2010) and 178 seconds on average (Bryan, Stone cipher, & Aron, 1954) after the loss of visual reference. These studies led to the FAA's and CASA's '178 seconds to live' educational campaigns. Gibb, Gray and Scharff (2010) also stated that 'spatial disorientation accidents have fatality rates of 90–91 percent, which indicates how compelling the misperceptions can be.'

1.18.2 *VMC to IMC (FAA Airplane Flying Handbook, Chapter 4)*

Unfortunately, accident reports indicate that continued VFR flight from visual meteorological conditions (VMC) into marginal VMC or instrument meteorological conditions (IMC) is a factor contributing to loss of control in-flight (LOC I). A loss of the natural horizon substantially increases the chances of encountering vertigo or spatial disorientation, which can lead to upset.

1.19 Useful or Effective Investigation Techniques

1.19.1 None.

2. ANALYSIS

2.1. General

From the available evidence, the following analysis was made with respect to this accident. These shall not be read as apportioning blame or liability to any particular organisation or individual.

2.1.1 Man

The pilot was issued a Commercial Pilot Licence (Aeroplane) on 3 February 2021 with an expiry date of 31 March 2022. He was issued a Class 1 aviation medical certificate on 21 January 2021 with an expiry date of 31 July 2021 with a restriction to wear corrective lenses. The aircraft type was endorsed on his licence. The pilot was not issued an instrument flight rating.

2.1.2 Aircraft

The last MPI was conducted on 20 January 2021 at 3759.2 airframe hours. The aircraft had flown a total of 2.8 hours since its last MPI. The aircraft was issued a Certificate of Release to Service (CRS) on 20 January 2021 with an expiry date of 19 January 2022 or at 3909.2 hours, whichever occurs first. On-site investigation and further post-accident inspection of the wreckage (airframe and engine) revealed no pre-existing failures prior to the accident; all damage was caused during the accident. Records indicated that the aircraft was airworthy and there were no recorded defects prior to the flight. According to the calculated approximate speed at time of occurrence, the aircraft had surpassed the maximum structural cruising speed at turbulent air.

2.1.3 Environment

The weather at the time of the accident was cloudy with low-level stratocumulus and cumulus clouds ranging from 1500-3000ft above ground level with tops up to 12000ft and also towering cumulus clouds with some light rain. The accident occurred during day light at Letsatsi Game Lodge in the North West province at GPS co-ordinates determined to be: 25°40'4.0" South 026°53'7.8" East, at an elevation of 4500 feet (ft).

2.1.4 Mission

This was an international ferry flight from FALA in South Africa to FYWH situated in Namibia during day light with a flight planned for VFR. The pilot of ZS-XAS took a decision to return to FALA after consulting with JHB Information about the deteriorating weather conditions at and around his position (Rustenburg). He had attempted to contact the pilot of ZS-XAT to alert him of his decision to fly back to FALA, but to no avail. The last ZS-XAT altitude recorded by radar control was at FL100 (10000ft), approximately 2nm south of the accident site. The aircraft descended from 10 000ft to 4 500ft at a ground distance of 2nm which equates to a descent rate of 2750ft per 1nm of ground distance. This indicates that the aircraft was at a high rate of descent before it impacted the ground. This is also evident with the approximate 45° angle that the aircraft clipped the trees. The ground scar that was made by the nose cone had an approximate radius of 1m and had dug approximately 0.5m into the ground. The right stinger had also dug into the ground on impact. The aircraft also folded onto itself before coming to rest.

The aircraft had surpassed its maximum structural speed as shown in Figure 7. This indicates that the aircraft experienced in-flight breakup. The aircraft was descending in a left spin towards the ground. The left stinger initially folded onto the rest of the left wing, causing some of the left-wing tip parts to fall off the aircraft. At approximately 450m, the left-wing stinger got severed and impacted the left-wing root fairing before falling off the aircraft. At approximately 100m, the right-wing flap and hopper door were also severed. To date, 12 aircraft parts were located on the flight path leading to the main wreckage. There was no sign of any trees on the flight path being clipped off by the aircraft, this indicates that the aircraft was still above the trees at that point.

It is probable that once the pilot entered an area of little to no visibility, he became spatially disorientated and lost control of the aircraft. The aircraft then descended at a fast rate and impacted the ground.

2.1.5 The investigation revealed that the aircraft was flown from an area of VMC to IMC and the pilot likely became spatially disorientated, resulting in loss of control and impact with ground.

3. CONCLUSION

3.1. General

From the evidence available, the following findings, causes and contributing factors were made with respect to this accident. These shall not be read as apportioning blame or liability to any particular organisation or individual.

To serve the objective of this investigation, the following sections are included in the conclusion heading:

- **Findings** — are statements of all significant conditions, events or circumstances in this accident. The findings are significant steps in this accident sequence, but they are not always causal or indicate deficiencies.
- **Causes** — are actions, omissions, events, conditions, or a combination thereof, which led to this accident.
- **Contributing factors** — are actions, omissions, events, conditions, or a combination thereof, which, if eliminated, avoided or absent, would have reduced the probability of the accident or incident occurring, or mitigated the severity of the consequences of the accident or incident. The identification of contributing factors does not imply the assignment of fault or the determination of administrative, civil or criminal liability.

3.2. Findings

3.2.1 The pilot was issued a Commercial Pilot Licence (Aeroplane) on 3 February 2021 with an expiry date of 31 March 2022. The pilot's Class 1 aviation medical certificate was issued on 21 January 2021 with an expiry date of 31 July 2021, with a restriction to wear corrective lenses. The pilot was not instrument rated.

- 3.2.2 The ferry flight was conducted under the provisions of Part 91 of the CAR 2011 as amended and in visual flight rules (VFR) and instrument meteorological conditions (IMC) by day.
- 3.2.3 The weather at the time of the accident was cloudy with low-level stratocumulus and cumulus clouds ranging from 1500-3000ft above ground with tops up to 12000ft and also towering cumulus clouds with some light rain. The last aircraft altitude recorded by radar control was at FL100 (10000ft) approximately 1nm north-west of FAMS.
- 3.2.4 The aircraft was originally issued a Certificate of Airworthiness on 15 November 2014 with an expiry date of 30 November 2021.
- 3.2.5 The aircraft was issued a Certificate of Registration on 18 September 2014.
- 3.2.6 The last mandatory periodic inspection (MPI) was conducted on 20 January 2021 at 3759.2 airframe hours. The aircraft had flown a total of 2.8 hours since its last MPI. The aircraft was issued a Certificate of Release to Service (CRS) on 20 January 2021 with an expiry date of 19 January 2022 or at 3909.2 hours, whichever occurs first.
- 3.2.7 Both aircraft had tracking devices installed and the operator was tracking them from FAWB. According to the tracking device, ZS-XAT took off from FAWB and made a descent to FALA without any event. It then took off again to FAWH, climbing to 6000ft AMSL approximately 50 miles from FALA; thereafter, it climbed to an altitude of 10 344ft AMSL at 0932Z when it disappeared from the tracking device.

3.3 Probable Cause

- 3.3.1 It is probable that once the pilot had entered an area of little to no visibility, he became spatially disorientated and lost control of the aircraft. The aircraft then descended in a left spiral with a high degree of disintegration before impacting the ground.

3.4 Contributing Factor

- 3.4.1 Inadequate flight planning.
- 3.4.2 Improper VFR into IMC.

4. SAFETY RECOMMENDATIONS

4.1. General

The safety recommendations listed in this report are proposed according to paragraph 6.8 of Annex 13 to the Convention on International Civil Aviation and are based on the conclusions listed in heading 3 of this report; the AIID expects that all safety issues identified by the Investigation are addressed by the receiving States and organisations.

4.2. Safety Recommendation/s

- 4.2.1 Safety message: It is quite critical for pilots to ensure that they obtain weather reports for the departure area/airport, en route and destination area/airport as part of their pre-flight planning

in order to make an informed decision whether to undertake or abort a flight due to unfavourable (bad) weather conditions.

5. APPENDICES

5.1 None.

This report is issued by:

**Accident and Incident Investigations Division
South African Civil Aviation Authority
Republic of South Africa**